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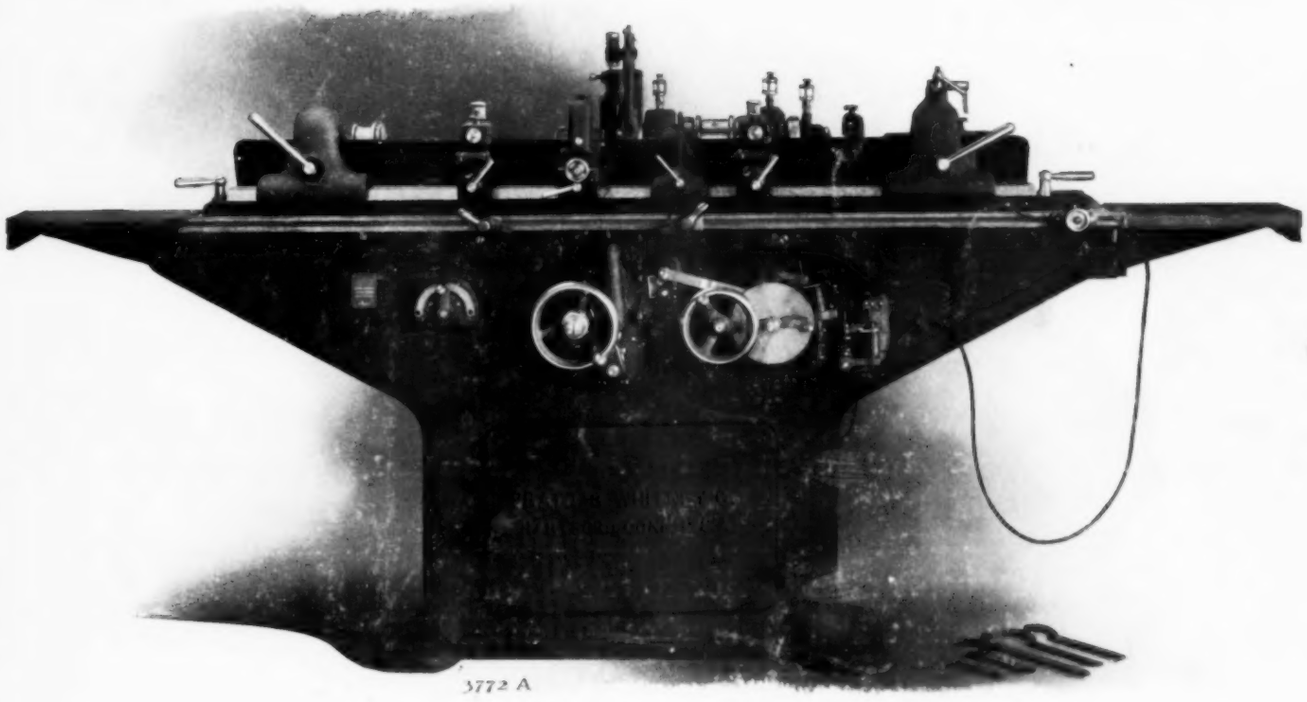
Index to Advertisers and Classified Index Following Reading Matter.

P&W

AUTOMATIC SIZING GRINDERS

P&W



5 x 48 INCH GRINDER WITH AUTOMATIC SIZING DEVICE.

Removing the last thousandth, usually the most expensive part of a grinding operation, is done on this machine at practically no cost.

The heavy coarse feed is automatically changed to a fine feed and work is quickly ground with a fine finish to exact size without calipering.

Machine measures faster and more accurately than any man can do it.

Wear of Emery wheel has no effect whatever, and wheel is worn out on the work—not by truing it up.

Write for illustrated circulars with complete description.

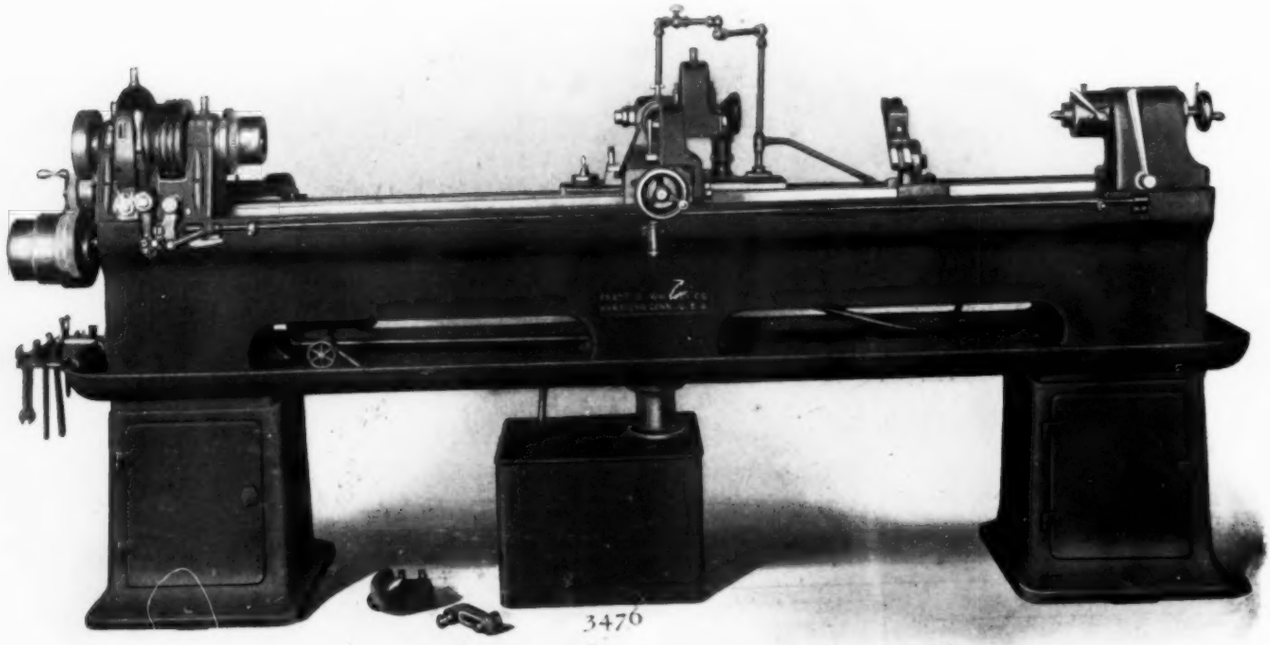
PRATT & WHITNEY COMPANY,

HARTFORD, CONN., U.S.A.

For Offices and Agents see pages 2 and 3.

THREAD MILLERS

The lathe cannot compete in accuracy, finish and output.



6x80-inch Thread Milling Machine. Regularly built in six sizes.

The thread milling machine, on account of its increased accuracy, finish and output, is far superior to the engine lathe for spiral gear, worm, flexible shaft and various other miscellaneous work. It will spline long shafts in a fraction of the time required by other types of milling machines and mills, and will mill from a straight line to a circle and any spiral between. Not only will it do work faster than the lathe but from two to six thread milling machines may be run by one man, thus reducing the labor cost.

Write for illustrated catalog "The Thread Milling Machine."

PRATT & WHITNEY COMPANY,
HARTFORD, CONN., U.S.A.

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A Double-spindle Spline Milling Machine

A Novel Machine with Two Cam-controlled Spindles and Reciprocating Table for Feeding the Work between the Cutters

SPECIAL CORRESPONDENCE

The machine illustrated by the accompanying half-tones and line engravings is of novel character. It is the latest product of the Pratt & Whitney Company, Hartford, Conn., and is known as a spline miller, although the operation suggested by the name is but one of a number which the machine is adapted to perform. Cylindrical, square or rectangular work within the capacity of the miller may be slotted clear through or grooved to any depth required. Drill sockets, tool posts, boring bars, etc., requiring oblong openings and crosswise slots are a few of the parts which may be readily handled on this machine. The general design of the miller is well brought out by the half-tone, Fig. 1 and the principal features of construction are illustrated in the line engravings Fig. 2 to 8.

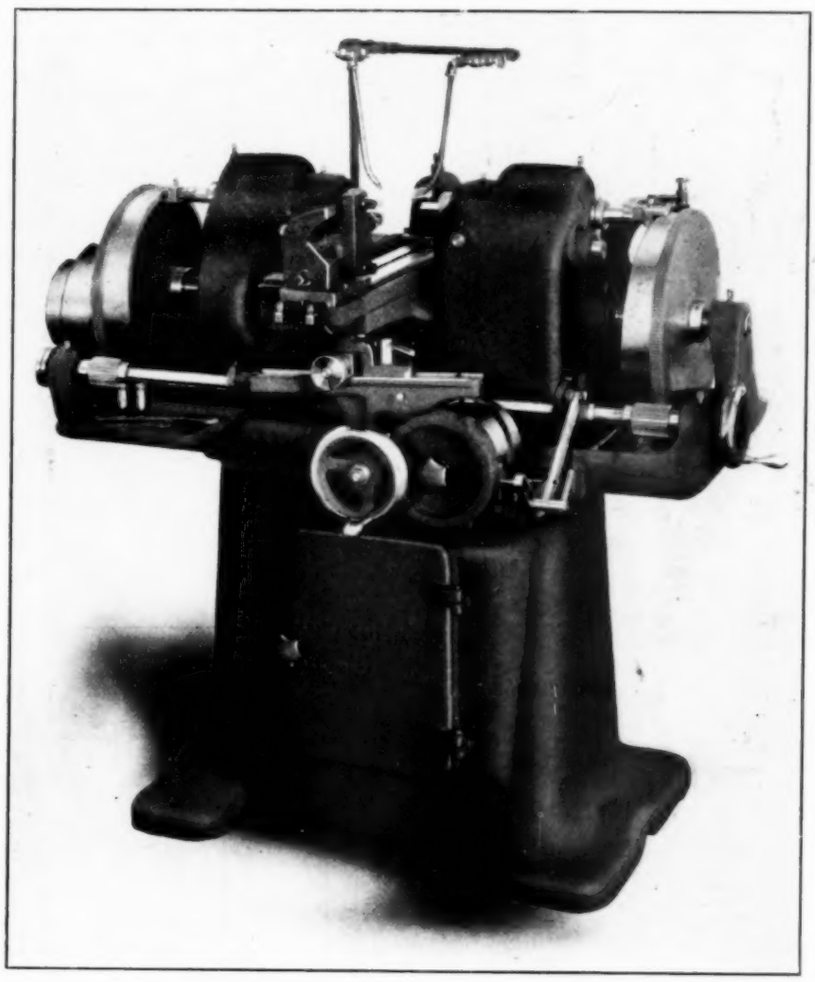


FIG. 1. DOUBLE-SPINDLE SPLINE MILLING MACHINE

Heads and Spindles

As shown in the general view, the machine is equipped with two heads and two spindles, each carrying a flat cutter of the "fish-tail" type operating usually under a flood of oil. Either cutter may be utilized independently when a single keyway or shallow groove is to be cut; or where a slot is to be milled through a socket, cutter bar, or some similar piece the two cutters may be employed simultaneously on opposite sides of the work. The latter is traversed past the cutters by a reciprocating table whose stroke is adjustable to suit the length of slot, and at each end of the stroke the cutters are automatically advanced a predetermined amount until the slot is completed. Ordinarily a rapid traversing movement is employed and a light chip taken at each stroke, producing a slot which is straight and true and accurate both as to width and length.

The Driving Mechanism

The method of driving is illustrated in the various line engravings. The three-step driving cone at the left end of the machine is mounted on a shaft which, as seen in Figs. 2 and 3, is connected by spur gears with the spindle in the left-hand head, and this spindle in turn is geared to the main shaft shown in Fig. 7, which shaft at the other end is geared to the spindle in the right-hand head. As indicated in Fig. 4, an extra gear is introduced into the train connecting the latter spindle with the drive-shaft, so the spindles, as viewed from their respective ends, rotate in the same direction, and cutters ground to the same hand may be used interchangeably in the two spindles.

Operation of the Table

The drive for the table mechanism is transmitted from the main shaft just referred to through a pair of gear cones shown in dotted lines at *A B*, Figs. 3 and 4, to a worm and worm gear shown at *C* in the sectional view, Fig. 6. The worm gear through the medium of a spur-gear train and a cone friction *D*, operates cam *E*, Figs. 3 and 6, and the cam imparts an oscillating movement to rocker arm *F* which carries an adjustable block connected by a pivoted rod to the underside of the table. This connecting-rod is shown at *G*, Fig. 8, and the cam rocker and other exterior members by which it is operated are all plainly shown in the half-tone Fig. 1. The nurled nuts on the threaded portion of arm *G* are employed to adjust the position of the table in its guide to suit the location of the slot to be cut in the work. The length of the table stroke is of course varied by means of the adjustable block carried in the slotted rocker arm *F* actuated by the cam *E*, Figs. 3 and 6.

Table Cam Control

The cam path is so laid out as to impart a practically uniform motion to the table throughout the length of the stroke. The throw is 2 inches and the maximum stroke of the table 5 inches. The cam has 5 rates of speed; its velocity and hence the rate of travel of the table is controlled by a sliding key which operates in the lower cone of gears at *B*, and which is itself controlled by a crank handle on a vertical shaft at the rear of the machine.

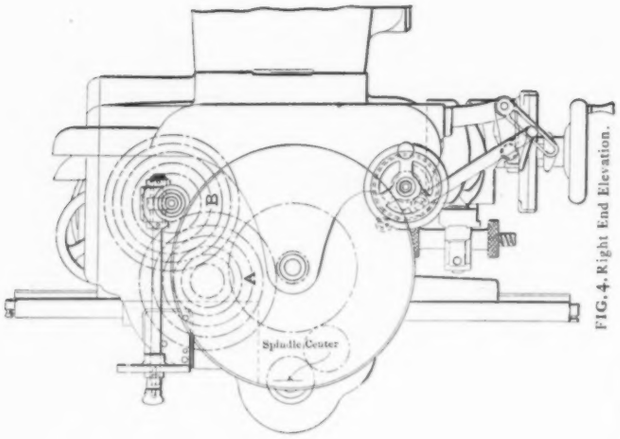


FIG. 4. Right End Elevation.

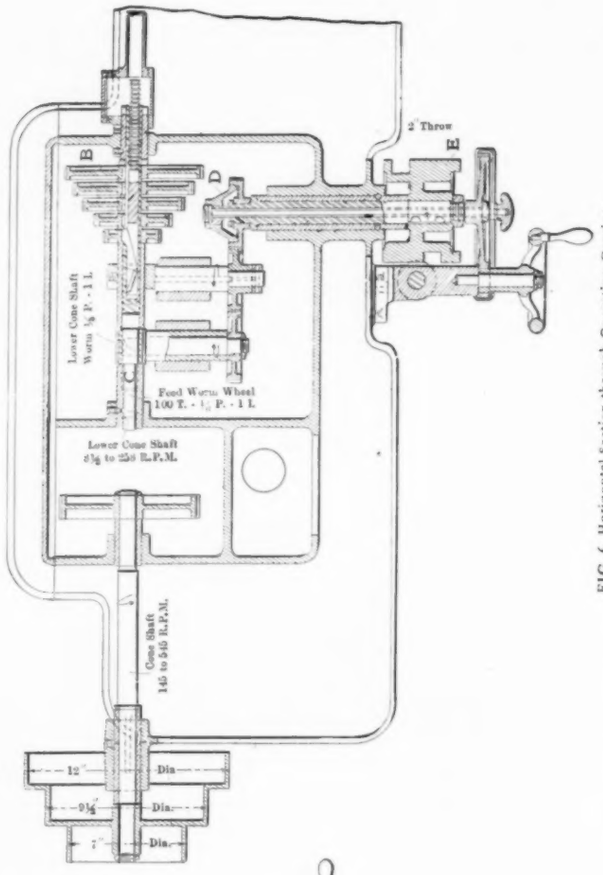


FIG. 6. Horizontal Section through Operating Gearing

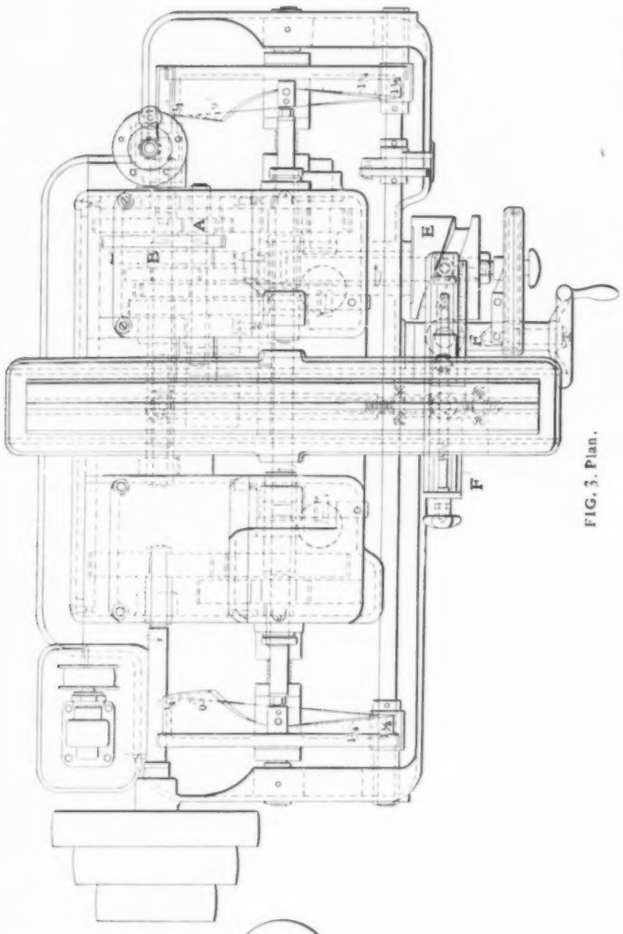


FIG. 3. Plan.

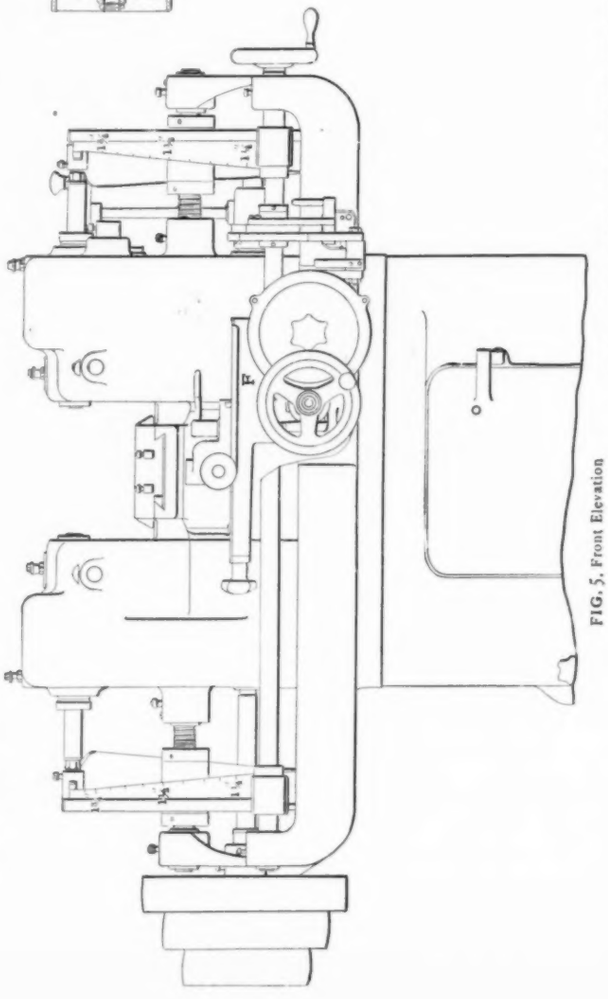


FIG. 5. Front Elevation

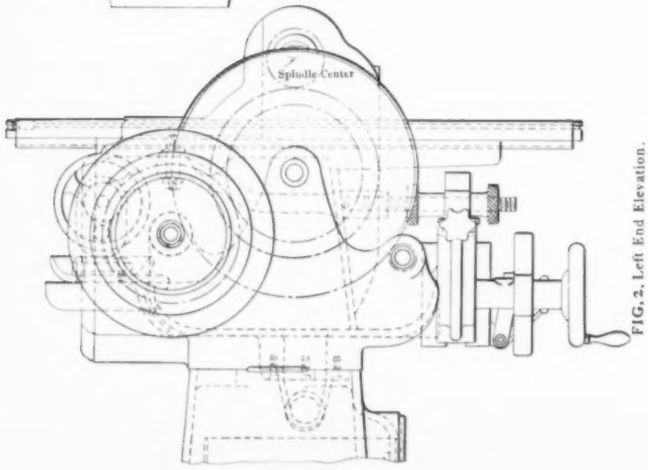


FIG. 2. Left End Elevation.

PLAN, ELEVATIONS AND SECTION OF SPLINE MILLING MACHINE

The friction *D* is controlled by a knob in front of cam *E* and when the table is to be manipulated by hand as in setting up for a piece of work, the entire gear train is released, leaving the cam free to be turned with ease by the hand wheel, to which it is connected by gear and pinion.

The Spindle Feed

The longitudinal movement of the spindles by which the cutters are fed into the work at the end of each stroke of the table is imparted by the two large cams located near the ends of the machine. Gear teeth are cut on the peripheries of these cams and the pinions by which they are rotated are fixed on opposite ends of a shaft which is turned forward by pawl and ratchet, and secured by a friction device against any tendency toward backward rotation during the idle movement of the pawl. The arm operating the pawl is actuated during the momentary dwell of the table at the end of its stroke by cam surfaces formed on the outer edge of the cam *E* which reciprocates the table. The depth of cut taken at each pass of the work is determined by the number of teeth on the ratchet covered by the oscillation of the pawl, the movement of which is easily regulated to give the desired spindle advance. The sectional drawing, Fig. 7, illustrates the method of mounting the cams and also shows the connection between cam and spindle which is self-explanatory. The short shafts carrying the cams are independent of each other and the inner ends are journalled in the boxes which carry the main shaft for driving the spindles.

Spindle Cam Adjustment

The cam-shafts are threaded and the nuts at *H H* provide means for adjusting the cam and the corresponding spindle endwise to suit the work, prior to starting up the machine.

The cam throw is 2 inches and the periphery of each of the cams is graduated in inches and sixteenths so that when a given graduation coincides with the zero line on the contact shoe at the rear end of the spindle, that graduation represents the exact amount of cam rise and forward spindle movement available before the cam completes its revolution. This facilitates the adjusting of the machine to the work. The contact member between spindle and cam is held against the latter by the counterweight shown in Figs. 7 and 8, which tends to draw to the rear the quill carrying the front end of the spindle. The spindle is thus always controlled longitudinally between the rear end of the quill and the edge of the cam.

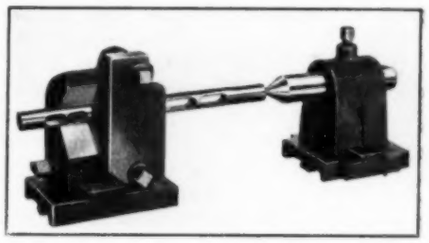


FIG. 9. VISE AND FOOTSTOCK

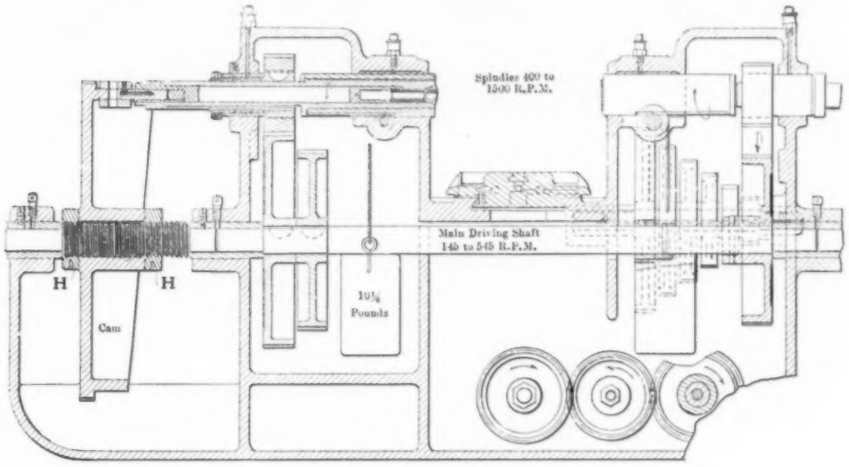


FIG. 7. LONGITUDINAL SECTION THROUGH HEAD AND SPINDLE

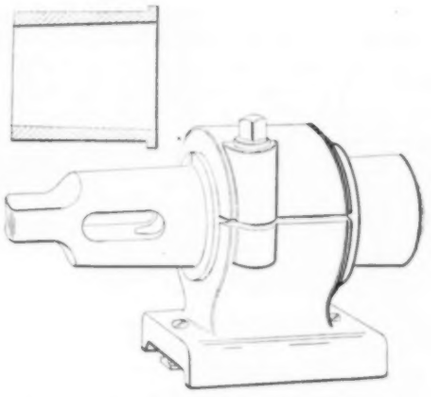


FIG. 10. FIXTURE FOR HOLDING TAPER SOCKETS

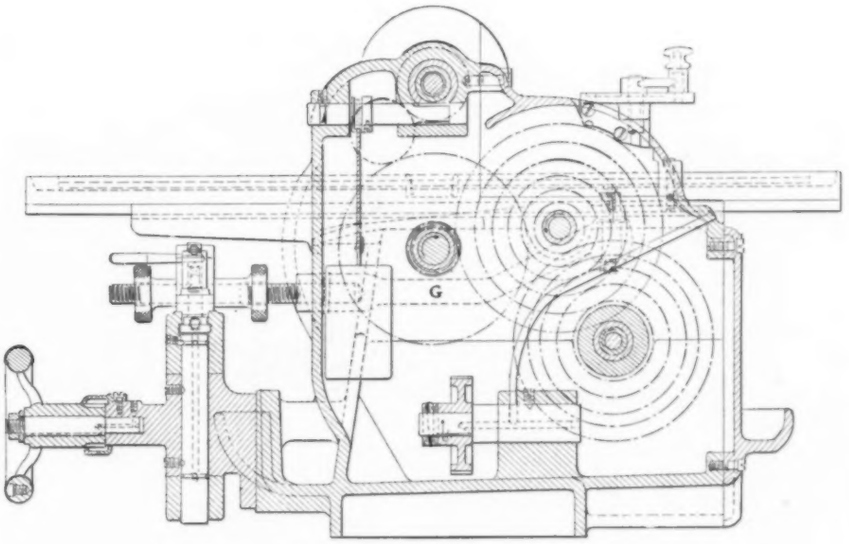


FIG. 8. CROSS SECTION THROUGH HEAD AND BED

Simultaneous Operation of Spindles

In cutting a slot through from both sides of the work, using the two spindles simultaneously, one cam is adjusted ahead one or more teeth in its driving pinion so that the corresponding cutter will reach the center of the work and withdraw from the slot while the other cutter has still a slight amount of metal to remove before finishing the opening. This slight rotary adjustment of one cam ahead of the other prevents any possibility of the cutters coming in contact with each other.

Prior to starting the cut, and upon determining the total longitudinal feed which each cutter is to be given, the cams are rotated to bring the graduation corresponding to that amount of travel opposite the zero lines referred to above. The cams may then be adjusted sidewise by nuts *H H* until the cutters are close to the work, and then if the slot is to be cut clear through the piece, one cam may be set ahead slightly in the manner described.

Holding Cutters and Work

It will be seen in Fig. 7 that the spindles are provided with draw-in collets for holding the cutters. This drawing also shows the table section which is a duplicate of that of the Pratt & Whitney bench-lathe bed, the center hight above the table also corresponding to the hight of the bench-lathe centers. This enables the regular bench-lathe attachments to be applied to the spline miller when desirable, as, for example, when two or more slots are to be cut in work held in the indexing head or where slotting or similar operations are required on a piece which it is not advisable to remove from its original setting in the bench-lathe attachment.

The method of holding plain cylindrical work is illustrated in Fig. 9. The center of the V in the vise is exactly the same hight above the table as the spindle centers, hence the simple operation of clamping the work also assures its location central with the cutters. As indicated, the vise and foot center have provision for side adjustment crosswise of the table.

For holding taper sockets the fixture in Fig. 10 is used. This is bored to the center hight of the spindles and by changing the split bushings various sizes of sockets can be accommodated.

Vise for Square Stock

Fig. 11 illustrates a vise applicable to a wide variety of square or flat parts requiring machining. A large number of such pieces which were held in this vise while undergoing slotting operations are shown in Figs. 12 and 13, which illustrate in striking manner the adaptability of this miller to the performance of a class of operations usually considered more or less difficult of accomplishment.

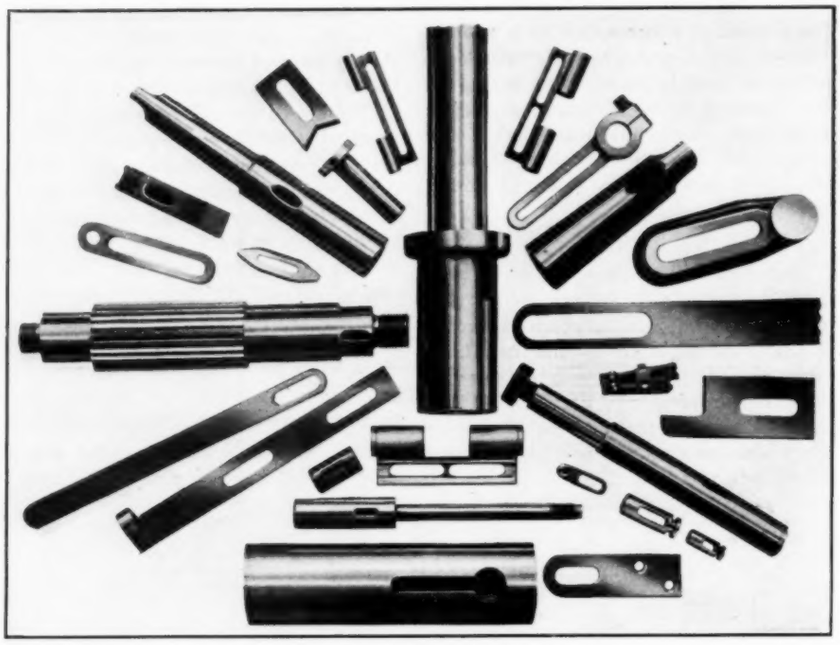


FIG. 12. WORK SLOTTED ON THE SPLINE MILLER

Referring again to Fig. 11, it will be observed that the vise there shown consists of a frame carrying a loose clamping jaw operated by a pair of screws, while the base is adapted to receive an adjustable work support in the form of a pair of wedge-shaped blocks tongued together, and the hight of which may be varied as required by sliding one block lengthwise upon the other.

Vise Adjustment

A hole is bored through the side of the vise at the exact hight of the cutter spindle centers and a hardened plug is ground and lapped to fit this hole. Half the diameter of the plug is ground away at the middle of its length as represented in the engraving, and when the plug is slipped in the hole with the flat surface in a horizontal plane, the flat represents the true center hight of spindles and cutters. With this center gage as a starting point the vise is readily adjusted to locate the work at the right hight relatively to the spindles.

If the piece to be slotted is of similar character to that shown in position in the

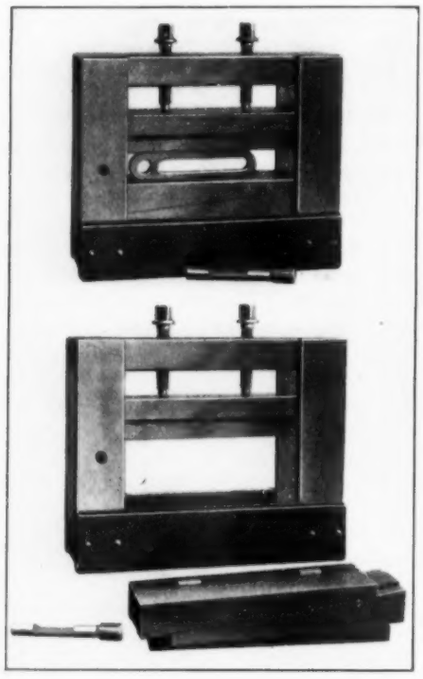


FIG. 11. VISE FOR SQUARE MATERIAL

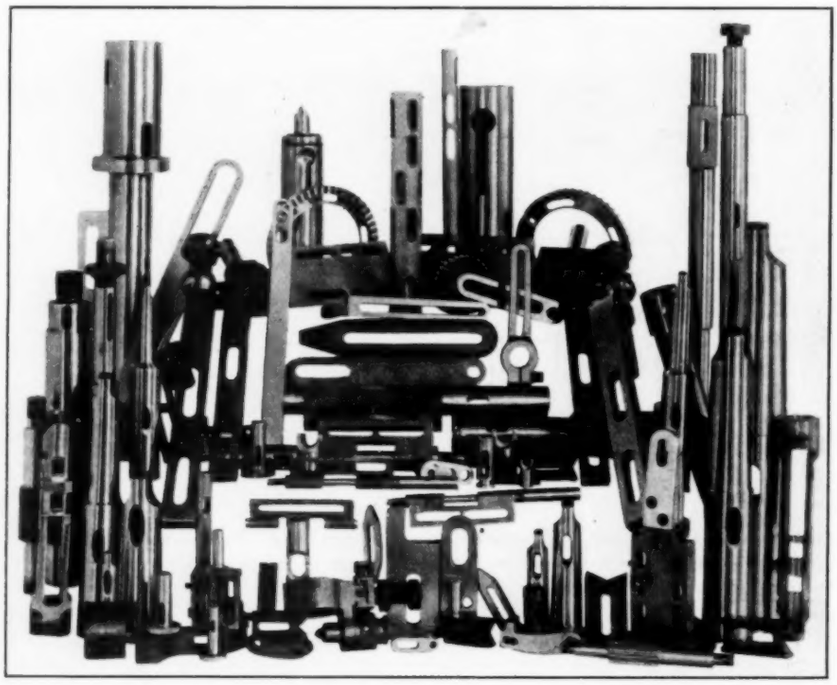


FIG. 13. WORK SLOTTED ON THE SPLINE MILLER

vise, and, for illustration, one inch wide, the slot to be in the center of the width, the double wedge-shaped support may be adjusted until a half-inch size block or plug gage will just pass between the upper face of the support and the flattened face on the centering plug. In this position the adjustable support for the work is obviously just one-half inch below the center line of the spindles. Provision is made for clamping the work support when set to the proper hight, and slots are machined in the working surface to carry stops against which the pieces to be slotted are placed before tightening the loose vise jaw.

A Cutter Grinder

Although the simple "fish-tail" cutters used in this spline milling machine may be

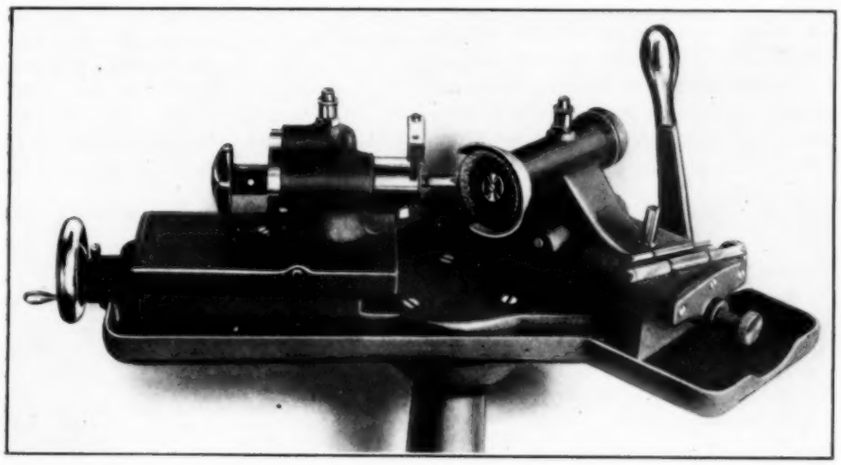


FIG. 14. GRINDER FOR "FISH-TAIL" CUTTERS

sharpened on an ordinary, thin emery wheel, to facilitate the grinding of the cutting edges to the most suitable angle and assure uniformity in the lengths and clearances of the lips, the special machine in Fig. 14 has been developed. The cutters, which are made double ended as indicated in this illustration, are held in a draw-in collet in the grinder head. The cutter is adjusted to secure the correct clearance angle for the lips, and after the wheel has been passed across the nearest cutting edge, is indexed halfway round by means of the knob at the rear end of the head spindle, thus presenting the other lip to the wheel. The method of adjusting the grinder head toward or from the path of the wheel and the manipulation of the wheel slide itself will be understood from the engraving.

It is impossible to ascertain the total imports into Japan of iron, machinery, etc., for military and naval purposes, but the imports of 488,434 tons of pig iron and steel, together with machinery made of iron and steel to the value of $7,084,470, indicates that the total consumption of iron and steel imported for all purposes will reach nearly 1,000,000 tons per annum.

High Priced Automobile Repairs

By I. B. Rich

A friend of mine who was a good mechanic and had been in the automobile-building game for some time, started an automobile repair shop to do as good work as he knew how and charge a fair profit for it, but to draw the line at hold-ups of any kind. That's what got him into trouble.

He'd fix up a machine the best he knew how—and that was pretty good—but the first he knew it would come back with a howl about the work not being good, the car not running right and the charges being high. He knew something was wrong, but couldn't just put his finger on the raw spot till one day a "chiffonier,' or whatever you call him, who had hit the wine when it was red, got confidential, and gave the snap away.

"Say, wot kind of a dub are you anyhow? Don't you know that repairs are worth about fifty simoleons a month to a good shoffer? Why don't youse open up yer glove and you won't have any more trouble with the cars you fix."

"So it's graft you want, eh? well I never—"

"Well you better start right now or we'll do you, see. My boss grafts and why shouldn't I?"

That was an eye opener. The best work he could do might be put out of commission by the driver as soon as he was out of sight of the shop and the owner would be perfectly justified in thinking it was his fault. The driver was next to the boss, who hired him for his knowledge and what he said went. If the driver said a repair could be made for ten dollars and was worth fifty, it put him in the light of a robber when in reality the driver had purposely named a low figure to get him in trouble. 'Twasn't a pleasant situation by a long ways.

So he began sending estimates of the cost of all repairs to the owners before he touched the cars at all, specifying what needed doing and what each part would cost. Some of the owners thought this was a nuisance and didn't want to be bothered, but it wasn't long before he had a fair line of customers who began to see that they had paid more money for similar repairs before and who woke up to the fact that the drivers were getting a rake-off on all repairs, and that it made quite a difference in the cost of repairs during a season. All of which goes to explain why some repair bills on automobiles are so outrageous to a man who knows what work ought to cost, and shows that while it is easier to play the graft game, it isn't necessary if you will go to the trouble to fight it out on other lines.

Reducing the Bore of Bushings

By Charles H. McClellan

Work on a lot of about 50 bronze bushings about 2 inches in diameter, 2¾ inches long with a ⅞-inch hole was started. The first operation was, of course, to bore the hole in each one, which, on being completed, were found to be about 1/32 inch too large. A hurried consultation among those directly concerned was held. The first consideration was to scrap the whole lot; but did not obtain for the reason that bronze castings were then worth at least 25 cents a pound, and last but by no means least, we wished to escape an inundation of wisdom from the powers higher up.

Just what to do—that was the absorbing question. We first thought to make a rough die and use the punch press, but this was too expensive and uncertain. The next consideration was to interview the blacksmith, but he had never tackled a job like that before.

Then we had the blacksmith heat one of the bushings until it was red hot and hammer it a bit, but it was found that the bushing had undergone a molecular change due to heating, and when it was struck it broke as if it might have been made of so much clay, the interior being granular and showing all the colors of the spectrum.

Next we had the blacksmith try it cold. A loose bar was inserted in the hole and, using a clapper, we commenced striking with a heavy hammer, and to our satisfaction soon found that the bushing was lengthening and was hugging the mandrel. This saved the day and really only took a very few minutes and we were enabled to rebore and save the bushings.

Everybody concerned went home with that peculiar feeling of rightousness of not having been found out, but withal a consciousness that he had learned something that day. It is entirely probable that this may not prove entirely novel to some readers, who can perhaps recall similar difficulties, but certainly was a new experience to the team which worked the degree.

Making and Using of High-speed Steel Tools

Composition of Metal, Forging, Grinding and Tempering of Lathe Tools and Milling Cutters. Results in Practical Work.

BY A. L. VALENTINE

So many different brands of high-speed steel are being made at the present time that it is difficult to keep in mind the good or bad qualities which each possesses. Some of those which have been marketed are almost worthless, and for that reason some manufacturers are prejudiced against high-speed steel in general.

From some of these steels a tool can be made from one end of a bar that is easily forged, machined and hardened, while the other end of the bar would resist most any cutting tool and would invariably crack in hardening. Different bars of the same make also give very different results.

In my experience I have found that these faults are sometimes caused by non-uniform annealing in the steels which are sent out as thoroughly annealed, and in many cases they are caused by the use of impure iron and other ingredients which enter into high-speed steels in their making. In the manufacture of this steel only the purest iron and alloying materials should be used, and the metal should be thoroughly annealed by the steelmakers before it is sent out, as a homogeneous steel that is uniform throughout the entire length of the bar can only be obtained by the most careful selection of the materials, coupled with skill and knowledge in its manufacture.

Another quite important point for the makers of this steel to take into consideration is that the users will invariably look for a steel capable of attaining the highest efficiency and yet require treatment of only the simplest kind.

As many undoubtedly know, regular carbon steel loses its intense hardness at about 500 degrees Fahrenheit. A good high-speed steel will stand a temperature as high as 1200 degrees Fahrenheit, or over double that of carbon steel, and experience has proven that the higher the temperature is raised over the white-heat point, or one might say the critical point when hardening, the higher a temperature of friction the tool will withstand, before losing its intense hardness.

Composition of High-speed Steel

Another thing which we should be somewhat familiar with is the ingredients of high-speed steel. Those which have come to my notice and been analyzed have shown a combination of iron with carbon, tungsten and chromium, and with tungsten, molybdenum and chromium.

These analyses have proven two things, viz., the same kind of steel does not always contain the same proportions of the above ingredients, and that these different proportions of the ingredients in the steel are productive of different results when making tests.

That the same kind of steel contains different proportions of the ingredients in different bars, is something left to the makers themselves to explain, as it is obvious that such conditions should not exist. Maybe they are resulting from faulty manufacturing conditions, or maybe that in order to obtain better results with them, or in order to cheapen the manufacture of the steel, the proportions of the ingredients are changed. In such a case, however, the users should be notified of such changes, and this is seldom, if ever, done.

Kind of Steel.	Carbon.	Tungsten.	Chromium.	Manganese.	Silicon.	Molybdenum.	Phosfor.	Sulphur.	Remarks.
a	0.705	14.91	2.95	0.01	.....	....	0.013	0.008	Not analyzed for other ingredients.
b	0.250	17.266	2.695	Trace	0.179	....	0.035	Trace	
c	0.75	14.83	2.90	0.08	.....	5.19	0.02	0.01	Not analyzed for other ingredients.
d	0.49	17.60	5.11	....	.....	....	0.01	0.007	Not analyzed for other ingredients.
e	0.649	.....	.....	0.19	0.039	9.60	0.016	0.005	Analysis given to the writer, but steel not tested or tried by him.
f	0.60	13.00	2.88	....	.....	....	0.019	0.01	Not analyzed for other ingredients.
g	0.55	17.81	2.48	0.11	0.090	....	.....	.....	
h	0.66	19.03	.....	....	0.036	....	0.015	.....	
a_1	0.791	14.291	2.85	....	.....	....	.....	.....	From same bar of steel as a, but analyzed by a different chemist.
a_2	0.800	13.40	2.93	0.06	.....	....	0.02	0.008	Same kind of steel, same size bar as a, but analyzed at a different time.

ANALYSES OF HIGH-SPEED STEELS.

Results of Composition

As regards different results being obtained from tools made of steels with different proportions of the ingredients, tests have invariably shown that the higher the percentage of carbon is, the more brittle and hard to work it will be, especially to forge. The steel which has given us the best all-around results has contained about 0.40 per cent. of carbon. Very little difficulty in the forging operation has been encountered with this steel, and the loss has been very small. The analysis of this same steel showed a percentage of nearly 3 per cent. chromium. Whatever variation there has been during different analyses these have almost always shown that whenever the percentage of carbon has been decreased, the percentage of chromium has been increased and *vice versa*. The amount of tungsten has varied between 14 and 18 per cent., as shown in the table. Here another interesting fact has presented itself, viz., the higher the percentage of tungsten in the steel the better has been its cutting qualities.

Tools Used in Tests

The most commonly used tools with which I have been able to make tests from the steels in the table are: First, lathe-turning tools; second, milling cutters; third, twist drills; and fourth, thread-cutting tools.

The hardening and grinding operation will be treated separately, as this will save repetition of many points which are the same for all of the above tools. Whatever facts are mentioned in this article refer to the cutting of tool steel, as I believe that from results obtained by cutting this metal deductions can be made easier and more correctly than if the tests had been made on other metals such as iron, brass, etc.

While special tests have not been infrequent, I have had the advantage to use the steel in an establishment where the premium system is in use, and where the different department foremen and the men at the machines are directly benefited by an increased output and consequently they have been my best aids in getting results from the practical commercial work.

Lathe-turning Tools

These are generally made from stock of the correct dimensions to suit the tool post of the lathe. The first thing to be considered when making a turning tool is the forging operation. To this a good many users attach but little importance and by some it is entirely omitted as they just harden the end of the flat bar and grind it to what they consider the proper shape.

This latter course I think needs but few comments to prove it entirely wrong. First, the cost of grinding to the proper shape, providing this was feasible, would by far exceed the cost of forging. Second, such a tool cannot be ground to the proper shape, as a lathe-turning tool ought to be offset toward the cutting edge, to get the pressure of the chips more toward the center of the bottom of the tool (see "On the Art of Cutting Metal," by F. W. Taylor, in the A. S. M. E. *Proceedings* for November, 1906).

The clearance angle is generally made 5 degrees, the angle of top side rake 15 degrees, and the angle of top front rake 7 degrees. These, I have found to give the best all-around results, although for tougher or softer steel, tools having more top side rake with the cutter point broader, seem to give better results.

Two points that no user should overlook are, that the bottom of the tool should be ground straight as shown in the lower view of Fig. 1, and it should be supported as far out toward the cutting point as possible, as illustrated by Fig. 2, to overcome the breakage and chatter of the tools.

Factors Governing Speed

Considering the three important factors, finish, size and output I have found, after closely and persistently watching the men at the machines that the best results are obtained when the tools are ground as often as every 1½ hours when cutting tool steel, both as regards the premium gained and in the quality of the work produced.

The reasons for the above results are that by frequently grinding the tools the machines can be run at a high speed. The time taken in grinding and resetting the tools is less than the time lost by the necessarily slower speed of those tools which are ground less often. It is also obvious that those having tools which are sharpened often, will be able to produce a better finish on the work than those using tools which are ground less often, on account of the tools being dull for a shorter period of time.

Milling Cutters

Next in importance to turning tools made out of high-speed steel come milling cutters, and it is in this field that the most satisfactory results have been obtained, unless it be with the possible exception of twist drills.

While some have been scared from using high-speed steel for milling cutters by reading some articles which have appeared on the subject that claimed they are impractical on account of the cost of material, difficulty in working and loss in hardening, these difficulties and objections are only imaginary. The only difference in cost, that I have experienced, is the cost of material and possibly the expense of producing the high heat necessary for the hardening. The only difficulty of any consequence that I have encountered in the making of these cutters, has been the uncertainty of the reaming of the hole. Sometimes we get it oversize, or of a size larger than the reamer itself, but as the holes invariably have to be ground this difficulty with its resultant loss has been very slight.

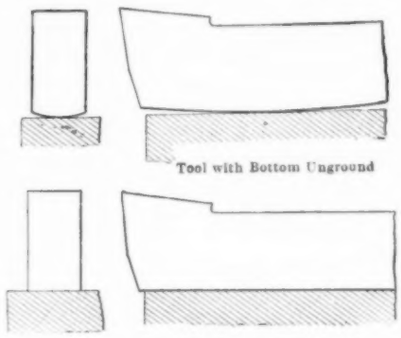


FIG. 1. GRINDING BOTTOM OF TOOL

It seems that in some way or another probably through molecular non-uniformity, a small piece of a chip adheres to one of the cutting edges of the reamer (this has happened with me with two different makes of steel) and acts as a cutter itself, thus making the hole larger than the reamer. It is plain to anyone, that in order to cut, this piece must be harder than the blank from which it was torn, thus giving foundation for believing the steel improperly made and not uniform.

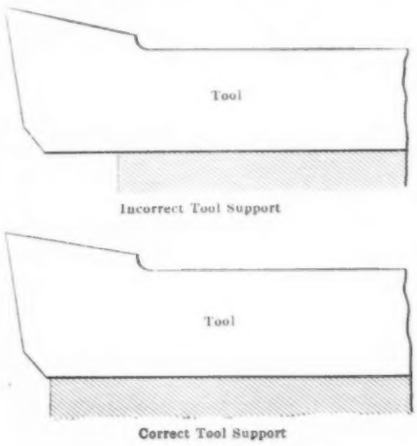


FIG. 2. SUPPORTING TOOL

Expense of Making Cutters

As far as the expense in milling a high-speed steel cutter goes, I have found no difference in the milling time of one of these cutters and one made of carbon steel, except that the fluting cutter might have to be ground somewhat oftener.

In the hardening operation comes the extra expense of producing the higher temperature at which these cutters have to be hardened. While I will admit that hardening for a time was a very uncertain and expensive operation, cutters are now hardened with as little expense and as little loss as was ever encountered with cutters made out of carbon steel, and the expense for increased equipment is hardly worth while mentioning.

In the beginning the real difficulty was to properly judge the white-heat point that sometimes resulted in a cutter coming out from the hardening bath all "pitted," and the cutting edges partly melted. Those cutters which had to be of exact dimensions, consequently became an entire loss. This difficulty was, however, speedily overcome by means of a pyrometer and a few tests, together with the more and more trained eye of the hardener.

Saving Effected

The financial results obtained by using high-speed steel cutters in manufacturing have proven so far beyond expectation that cutters made out of this steel are exclusively used in all lines of manufacture, except a very few specified cases. When premium prices could be cut as much as 300 per cent., as they were in some cases, from what they were when using cutters made out of carbon steel one can realize what an enormous benefit this steel has been. This enormous cut in premiums was made possible only through extensive tests and experiments, and not because prices were set out of proportion and excessive before the introduction of high-speed steel in the cutters.

Before leaving the milling cutters I would mention the failure to maintain an absolutely sharp point on any cutters made out of this steel. When such ends had to be obtained I have always been obliged to fall back on carbon steel. No matter how slow a speed or what lubricant was used the results were always the same as the extreme sharp point rounded over just enough to prevent the using of the cutter on such work as a nurl or similar tool where the bottom of the cut should be absolutely sharp.

Twist Drills

There are probably no tools unless it be lathe turning tools, on which high-speed steel has been put to so severe tests as on twist drills. The most exhaustive experiments have been made with high-speed twist drills, and more satisfactory results in general have been obtained than with any other tools.

The drills are made exactly the same as those out of carbon steel, except possibly the web of the drill being made somewhat thicker toward the shank; no additional expense is necessary in the manufacture of them, except the additional expense of producing the high heat necessary for hardening, and possibly the expense of polishing the flutes.

Fluting Drills

Polishing the flutes was found to be necessary for two reasons. First, all attempts and experiments we made failed to produce a fluting cutter which will produce as smooth a surface as the same cutter would in carbon-steel drills.

Everyone who has seen carbon-steel drills will find the flutes smooth and not polished. While the flutes in the high-speed steel drills may be smooth enough for all practical purposes, it has always been my endeavor to make tools not good enough, but the very best which can be made and obtained from anywhere. When taking into consideration that a large percentage of all these drills sold are being used for test purposes, this small additional expense has been repaid many times when we consider the increased number of drills sold.

The reason for not having been able to produce as yet a smooth flute in a high-speed steel drill I have attributed to the non-homogeneity of the steel, as the fluting cutter pulls out small particles of the steel in its progress leaving the cut surface somewhat rough.

Cutting Edge and Some Tests

As yet all attempts and experiments with different lubricants on the cutters, differently milled teeth in them, and what is of more than ordinary importance, different reliefs of the cutting edges, have been of no avail to produce smooth flutes.

If smooth flutes could be obtained in the fluting operation it might even then be necessary to polish them, as the high heat required when hardening will pit the steel more or less, and leave them rough. This would be a serious defect in an otherwise good drill. In this connection it might be well to state that with the ordinary rules and precautions used when hardening carbon-steel drills, not over 25 per cent. of the high-speed steel drills have to be straightened, and that consequently the "breaking when straightening" item is very small.

A few examples of the every-day work which we do will show what these drills are capable of. A ½-inch drill, run at 650 revolutions per minute with 4 inches of feed per minute drills 196 inches of tool steel before having to be reground, a ¾-inch drill run at 350 revolutions per minute with 2¾-inch feed drills 125 inches of tool steel, and a 1-inch drill run at 250 revolutions per minute with 2-inch feed drills 130 inches before having to be reground. The amount of inches drilled will, of course, vary somewhat, but the above examples give an idea of the speed and feed, which would be used of these drills. In all cases a strong flow of soda water should be used when drilling.

Thread-cutting Tools

Probably no tools made out of high-speed steel have given the experimenter and hardener more trouble than have thread-cutting tools, tools which cannot be ground after hardening, and tools in which the grinding operation is a commercial impossibility.

When considering thread-cutting tools the two main difficulties encountered are: To cut a smooth thread and to maintain this smooth thread during the hardening process, or to make it plainer, to harden the tool at such a heat that the steel does not become pitted, and still approach this point as near as possible. The higher the temperature at which a tool is hardened the higher a temperature of friction it will withstand before losing its intense hardness.

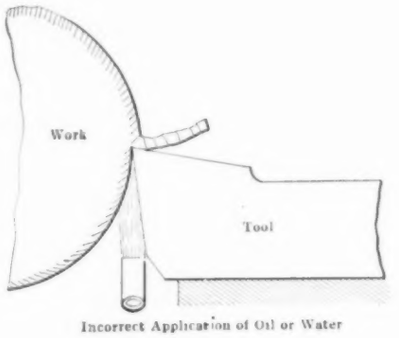


FIG. 3. CORRECT APPLICATION OF OIL OR WATER

The correct degree of heat at which to harden a thread-cutting tool such as a tap or die was very easily ascertained after a few experiments by means of the pyrometer. The real difficulty lies in cutting the thread smooth and in a somewhat reasonable time.

The most economical way I have found to cut out external threads on this steel has been to rough out the thread as close as possible to size with a chaser, using no lubricant whatever, and then finish the thread with a single-point cutter, using just enough of very thin oil to keep the threads moist. A spring-thread tool holder should be used in all cases. Still far better and quicker results will be obtained if the thread can be milled, using a flow of thin oil on the cutter.

As a thread-milling machine is not included in everybody's equipment the first way of threading was given.

Relief and Oversize Allowance

Another point not to be disconsidered is that these taps should invariably be given more relief than that given to common carbon steel taps, as no matter how carefully the tap is hardened, the threads will have a somewhat rough surface, and this means a tap that is not as free cutting as it should be. To eliminate this taps made of high-speed steel should be given more relief than taps made of ordinary carbon steel.

Very little allowance need be made for loss of size in hardening. This generally takes place when the tool is exposed to the air on account of oxidation. In fact, taps made out of this steel can be hardened with more certainty than can common carbon-steel taps, both as regards size and lead. The largest amount of error in lead I have found in any tap has not exceeded 0.0005 per inch. Ten 1-inch No. 8 U. S. S. taps were left 0.002 oversize all over, before hardening. After hardening they were 0.001 smaller on outside diameter, 0.0005 smaller in angle of thread, and what I consider the most remarkable result, the error in lead was a slight amount, less than 0.0005 per inch and exactly alike on every tap.

Hardening

Probably one of the most important factors to be considered when hardening high-speed steel is to see that the heating is done uniformly, and that the heat extends through the whole of that part of the tool to be hardened. If this is not done internal strains are sure to arise and be the cause of subsequent loss.

The tools to be hardened should be preheated slowly to about a cherry-red and then heated up quickly in the high-speed steel furnace to as near the melting point as possible without injuring the tool. This point can be approached with comparative safety on tools for turning, and on tools which can be ground after hardening, or where the size of the tool is of no account. On tools which cannot be ground after hardening one must make sure not to approach this point too close, as the tools will surely be ruined by the cutting edges having been burnt.

A good preventative from getting the cutting edges burnt and to preserve them in general and still be able to approach the melting point very closely will be found in a paste, in which that part of the tool to be hardened should be dipped. The tool to be hardened should first be thoroughly cleaned as the paste will not adhere otherwise. The paste is composed as follows and should be carefully handled as it is a poison. One-fourth pound cyanide of potassium dissolved in one quart of water, ½ pound of flour, 1 ounce of pulverized charcoal, 1 ounce borax and ¼ of a pound of salt.

Cooling After Hardening

Although the air blast probably is the

best medium for cooling, it is by no means the cheapest nor is it available to everybody, therefore I would recommend the using of fish oil as it is cheap and answers every purpose. The oil should be kept stirred up, and at all times be kept cool. The receptacle for the oil should be kept as near the heating furnace as possible, so that the time the tool is in contact with the air is reduced to a minimum to prevent oxidation.

Tools not to be hardened their entire length, should only be dipped as far up as they have been properly heated, as to immerse further frequently results in cracks.

As regards the drawing of the temper of high-speed steel tools, I would recommend an oil tempering furnace in which the oil is heated up to the temperature to which the tools are to be drawn. The degree can be ascertained by a thermometer immersed in the oil. The tools to be drawn should be placed in the tank before starting to heat the oil, to insure uniform heating of the tools throughout and not on the outside only.

Degrees of Temperature

As to the degrees of temper to give to the different kinds of tools, this is a very uncertain factor depending not only on the kind of high-speed steel used, but on what the tool is to be used for and of what shape it is.

For a guide to those not familiar with the degree of temper to which to draw tools made out of high-speed steel, the following figures are given as a guide: Twist drills, 430 degrees Fahrenheit; threading tools and chasers, 470 degrees; taps (large), 450 degrees; taps (small), 470 degrees; threading dies, 460 degrees, and reamers, 410 degrees.

Grinding

The grinding of high-speed steel presents but very few difficulties, added to those everybody is having when grinding other metals. The most important points to be considered are: Always use a soft wheel, and at all times keep the tool to be ground perfectly cool. A soft emery wheel should always be used, as this will heat the work to be ground less than a hard one would, and a soft wheel always means a sharp wheel. The expense for emery wheels will of course be greater than when grinding carbon steel, as a soft wheel naturally will wear quicker than a hard one would. A heavy stream of water should always be used on the cutting edge of the tools being ground. A turning tool must be moved forth and back across the face of the wheel so as to avoid heating, especially when grinding the flat surface.

Uses of High-speed Steel and Its Economy

After a close analysis of the foregoing observations gathered from actual experience, one would think, judging from the results obtained with these steels in practically every line, that they would have to be used by everybody in order to keep up with the keen competition of modern times. However after a short trial some abolish their use altogether.

The only reasonable excuse for not using high-speed steels which I can think of is that some think they are not needed. Where the present machines and tools can take cuts as heavy and at as high a speed as the work to be cut can stand, this might appear to be so. In this case, however, one will find that the use of high-speed steel will pay, as the cost of resetting the tools often on account of frequent grinding, not to mention the cost of the grinding operation itself, will in most cases by far exceed the difference in cost between a high-speed steel tool and one made out of carbon steel.

Erroneous Limitations

The main reasons in my opinion why these steels are not used to a greater extent than they are, are on account of misleading experiences with them, and in the use of worthless high-speed steels or in improper treatment and improperly made tools out of otherwise good steels.

It is obvious that to discontinue the use of these steels from reasons as above stated, is entirely wrong. It is a well-known fact, that many of the largest and most prominent manufacturers in this country are today using them with pronounced success and good results.

It will also be found that the increased speed and feed the machines are able to withstand makes the extra cost of these tools hardly worth mentioning when compared with the saving of time and increase of output.

Punch Press Shearing Operation

By L. W. G. Flynt

We had an order for several thousand of the pieces shown in Fig. 1, which are made of soft steel 0.020 inch thick drawn up into shells, in two operations, in the usual manner. The difficult proposition was to cut off one side and part of the end, the cut having to be in a slanting direction, leaving the edge at the end a part of a circle with a 1¼-inch radius. The tools illustrated in Figs. 2 and 3 accomplished the operation successfully.

The lower shear *A*, Fig. 2, which has a hole through it to facilitate the removal of the shell after the operation has been performed, is so mounted in the shoe *B* that its shearing face stands perpendicularly. The clamps *C* and *D* are pivoted on the extension of the shoe, as shown,

FIG. 1

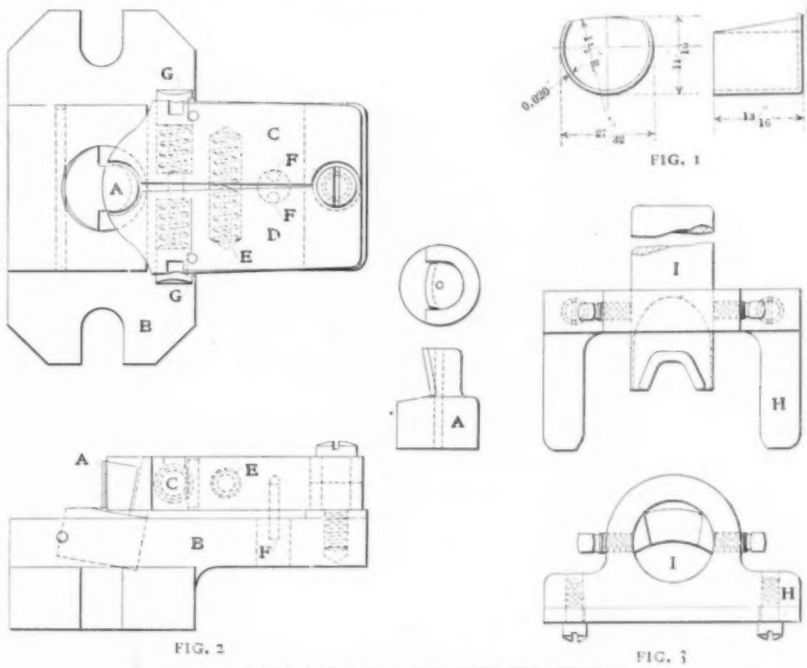


FIG. 2 FIG. 3

PRESS TOOLS FOR A SHEARING OPERATION

and are kept open by means of the spring *E*, to allow the shell to be placed on the shear post *A*. Two pins *F F* in the clamps extend into the hole drilled in the shoe limiting the amount of opening. The spring buffers *G G* are arranged to engage with the inner faces of the yoke plate *H*, which is secured to the upper shear *I*, Fig. 3, and serve to securely clamp the shell to be cut, and support it right up to the shearing edges of the post *A*.

Objections to be pointed out are: First, the difficulty of setting the tool up in the press, which might be overcome by arranging guide posts and thus making it into a sort of sub-press fixture. Second, the fact that when the shearing post *A* needs grinding it must be thrown away and replaced with a new one, as it cannot be ground without losing its necessary dimensions.

New 5-Cylinder Aeronautic Motor

Gyroscopic Acting. Stationary Single-throw Crank-shaft. No Fly-wheel. No Muffler. No Cooling Device. Vibration Eliminated

SPECIAL CORRESPONDENCE

A gasolene motor of exceedingly light weight per horse-power developed has been brought out by The Adams Company, of Dubuque, Iowa. The motor is the design of F. O. Farwell, patentee of the revolving cylinder motor used in the Adams-Farwell motor car, and while it is built on the same general lines as the automobile motor, by refinement it becomes an interesting example of light weight and possesses many interesting peculiarities. The motor has five cylinders, of 4¼-inch bore and 3½-inch stroke, and is run at a speed up to 1800 revolutions per minute.

The motor complete, in operative condition, with timer, float-feed carbureter, automatic force-feed oil pump and oil tank, weighs 97¼ pounds. With the spider, which secures the motor to four tubes, as shown in Figs. 1 and 2, the motor, base and all weighs 104 pounds. By the A. L. A. M. rule this motor is rated 36 horse-power. In Fig. 1 is shown two of these 36-horse-power motors held in the hands of two men, while one of the motors is running at full speed. The absence of vibration is shown by the clearness of the photograph of the parts not in motion.

Its weight per horse-power developed is believed to be the lightest of any motor not sacrificing strength and durability to weight. In comparing weights it is well to take into consideration the fact that the weight of the water, radiator, piping and fan used in water-cooled motors are not often given with the weight of the motor. The light weight of this motor, which is air-cooled, is brought about more by the simplicity of its construction and the high grade of the material used than by the reduction of strength to the minimum, and it is supposed to stand as hard and continuous use as the regular automobile motors, some of which have been in use for eight years and are in fine running condition today.

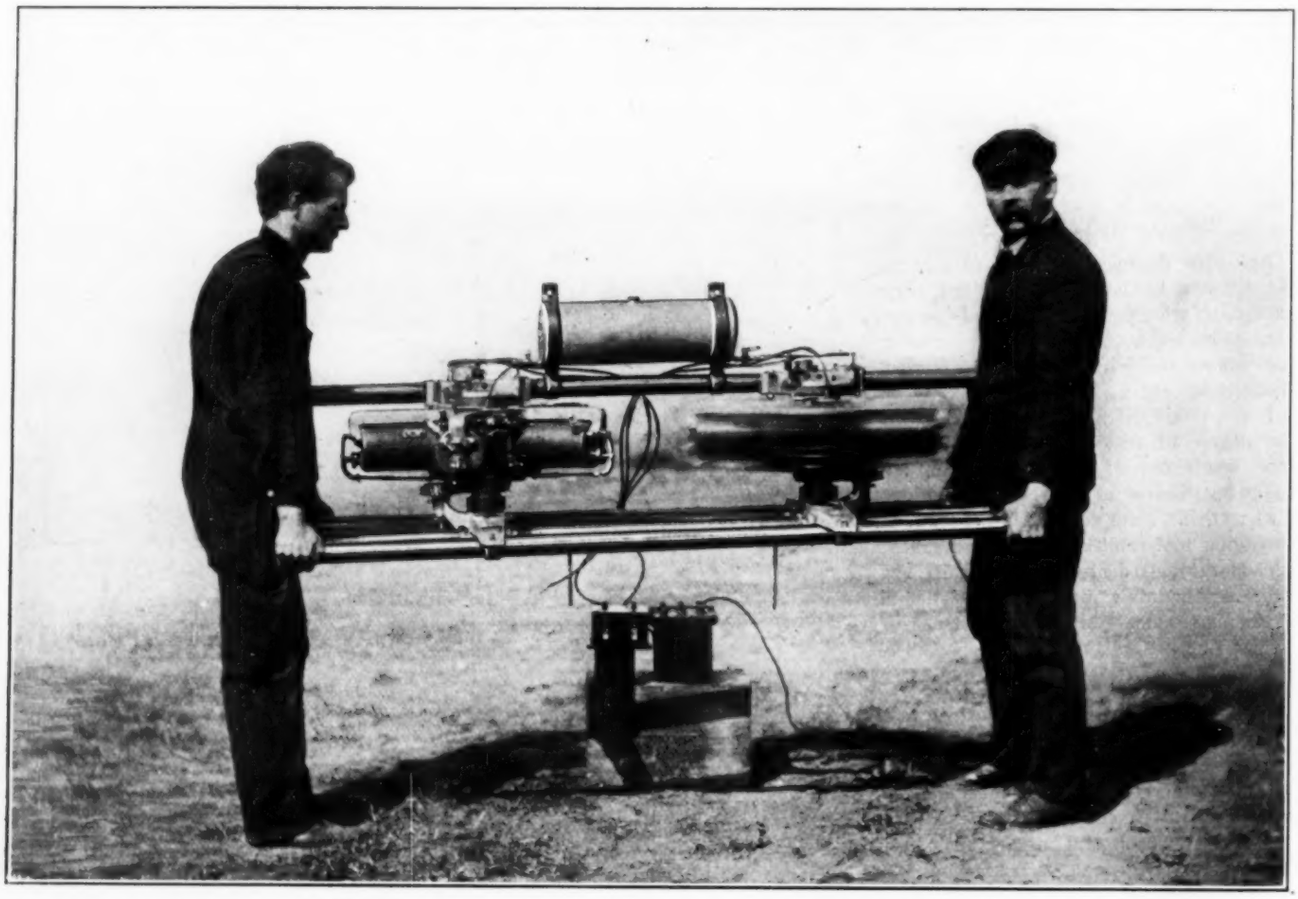


FIG. 1. ONE ENGINE UNIT RUNNING TO SHOW THE ABSENCE OF VIBRATION BY THE CLEARNESS OF THE STATIONARY PARTS

Revolving Cylinders

This Adams-Farwell motor is not what is usually termed a rotary engine. The cylinders revolve as one piece around a common center—the vertical stationary crank-shaft—and are in perfect mechanical balance. The pistons and connecting-rods revolve around another common center—the single crank-pin. At one point the pistons reach the head of the cylinder; at another point the pistons approach the base of the cylinder, but no moving part ever comes to a stop while the engine is running. It spins like a top.

Each cylinder is complete with head and part of the central crank-case cast in one piece of steel of high tensile strength and they weigh only 7½ pounds each. Five of these cylinders are bolted together and bolted to a top aluminum flange (which also forms the gas manifold) weighing 3 pounds, and to a bottom steel flange which also supports the valve cam and transmission gear. These flanges have

long bronze bushes and form bearings around the vertical stationary crank-shaft. In each cylinder is a cast-iron piston weighing 2½ pounds. All the pistons are connected to a single crank-pin by bronze connecting-rods which interlock each other around a bronze-lined steel bush about the crank-pin.

Cylinder Cooling

By revolving the cylinders instead of the crank-shaft very desirable features for aeronautic, speed-boat and automobile motors are secured.

The feature of cooling is perhaps among the most important. Without one ounce of cooling device the makers claim the best cooled of all gasolene motors. The cylinders move rapidly through the air like the arms of a centrifugal blower. Centrifugal force removes the air in contact with the cylinders and atmospheric pressure supplies fresh air. The circulation of air is equally rapid on all sides of all cylinders, and as the cylinders are of an equal thickness on all sides the expansion is equal and the cylinders may be made light without fear of distortion. The result is entirely different from blowing air upon side of cylinder or row of cylinders.

Those who are not familiar with the results obtained by the use of the Adams-Farwell cooling system, may question the advisability of making these cylinders smooth and without radiating flanges. The automobile motors have always had longitudinal flanges cast with the cylinders. During the summer of 1907 a seven-passenger automobile was provided with a motor of 5-inch bore and 5-inch stroke, with five smooth cylinders. This machine was used to test the cooling quality of the flangeless cylinders. It seemed to cool perfectly under the most severe conditions, such as climbing long, steep hills and long runs in deep sand. The tests made proved that the flanges were unnecessary as it is the enormous volume of air that does the business.

Water-cooling systems are a great handicap especially on aeronautic motors. The *Motor Print* of May, 1908, in speaking of the flying machines of Henry Farman and Leon Delagrange, says:

"The motors on both machines are of the water-cooled type, and this has been a constant source of inconvenience. In fact, apparently the only thing that has limited the flight thus far has been the necessity to stop for water."

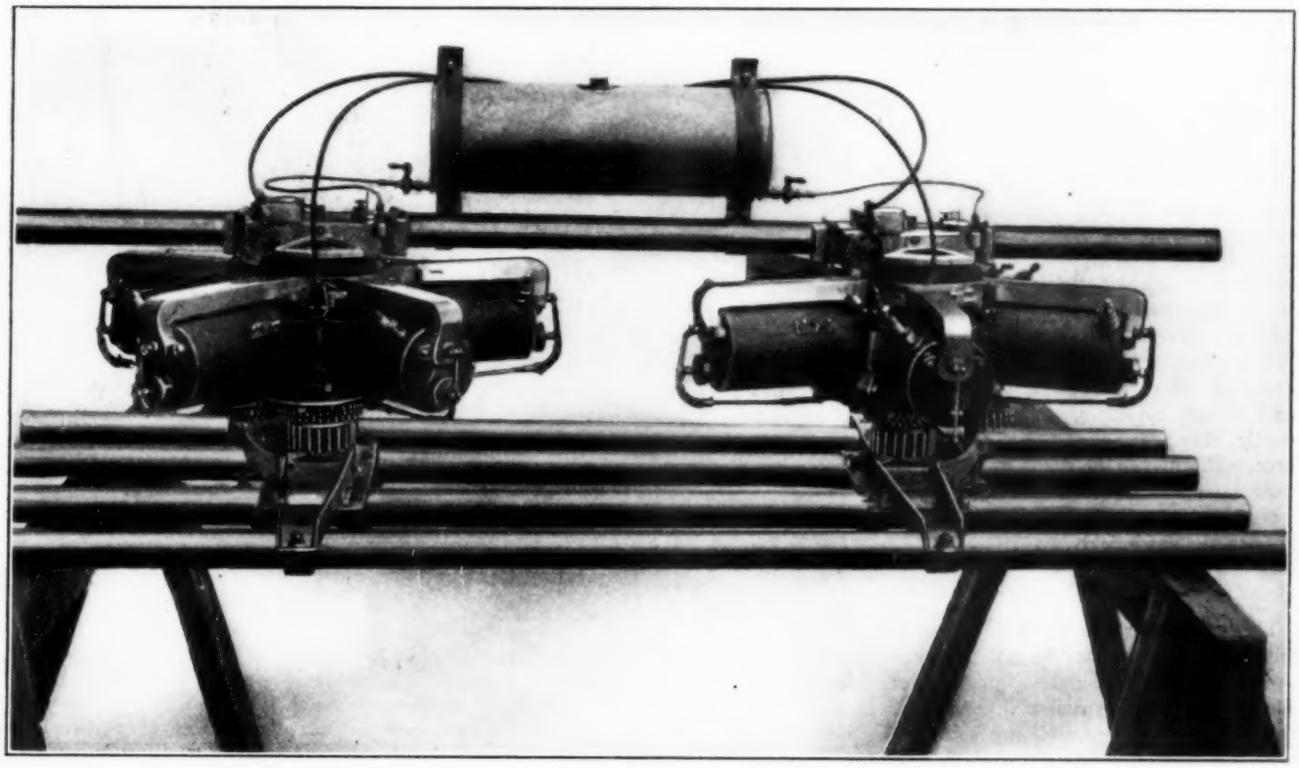


FIG. 2. TWO ENGINES ASSEMBLED WITH GASOLENE TANK, READY TO BE INSTALLED

Fly-wheels

While not an ounce of weight is added for balance or fly-wheel the revolving element that is utilized for balance wheel is over 80 per cent. of the entire weight or mass of the motor. This heavy fly-wheel revolving rapidly around a vertical axis exerts an enormous gyroscopic force to keep the motor and that to which it is attached in a true plane. The motor spins like a top, and like a top it has a tendency to resist being tipped over while spinning. It also has a tendency to quickly right itself if forcibly thrown out of its proper running plane. This force can be utilized to maintain equilibrium in a flying machine. Gyroscopic force is the only known means of obtaining a leverage without the use of a fulcrum based upon the earth.

The heavy fly-wheel is also conducive to very steady running and transmits a constant torque to the propeller. A gasolene motor, particularly one using high compression, transmits its power by a series of violent explosions or blows, and even though several cylinders may be used to divide up this series of blows, the arms of the propeller or fan used to propel a flying machine are subjected to destructive strains unless a fly-wheel of sufficient weight is interposed between the motor and propeller to absorb and distribute this series of blows.

A heavy fly-wheel also permits of the use of high compression which is more economical and produces more power from the same cylinder sizes than the low compression usually used in automobile and aeronautic motors.

This heavy fly-wheel, together with the variable-compression system used for controlling the motor speed and power, permits of a very wide range of speeds under-load.

Variable Compression

The variable-compression system referred to has been used for several years on the Adams-Farwell automobile motors and consists in mechanically holding the inlet valve open for a part of the compression stroke and closing it after a part of the gas has been blown back and taken in by another cylinder which is at the time on the suction stroke.

The compression is relieved and the motor is easily turned when it starts and runs slowly. The compression may be gradually increased until maximum speed and power is obtained and it may be as gradually reduced when stopping the motor. There is not that abruptness in starting or stopping which characterizes the ordinary gasolene motor and the propeller arms are thus relieved of much strain.

After the motor is started the spark lever is set and requires no further attention. All speeds are obtained by the variable-compression lever. The proper firing is cared for automatically.

Parts Simplified which Reduce Weight

The simplicity of this motor and the reason why it can be made so light without sacrificing strength will be better realized when it is understood that, in addition to saving fly-wheel and cooling-system weight and complication, the following essential elements are greatly simplified:

The crank-shaft in this five-cylinder motor is just like the crank for a one-cylinder motor. It is a short, single-throw crank, and although the bearings are large and long (1⅜x2¼, 1⅜x4 and 1⅜x3⅝ inches), the shaft weighs only 4½ pounds.

All the valves, ten in number, are operated by one cam. The valves have no springs to close them; but being in the head of the cylinders, and closing outwardly they are closed by centrifugal force. The higher the speed of the motor the greater this force and the greater the necessity for a stiff spring or force to close the valves quickly.

Ignition System

The wiring for the ignition system of this five-cylinder motor is just as simple as it could be for a single-cylinder motor. There is but one spark coil, one timer contact, one primary and one secondary wire. Fig. 3, showing the top view of the motor, will enable us to explain the ignition system. The primary wire is attached to a flat steel spring which is insulated from the remainder of the timer by a fiber block, not shown. A hardened-steel wheel is free on an eccentric or cranked end of a short shaft which is geared to the motor and makes one revolution to each two-fifths of a revolution of the motor.

A distributor for the secondary current is formed by a strip of brass on the lower edge of a segment of fiber supported by a bracket, as shown by the photos.

A short bare wire leads from the spark plug on each cylinder to a fiber insulator near the crank-case. In the top of this insulator is a screw, which, when the motor turns, passes under the distributor, but does not touch. When the cylinder which is to be fired passes under the distributor, the timer-wheel makes contact with the spring and the secondary current passes to the spark plug of that cylinder. Each alternative cylinder is on the power stroke as it passes the dead center of the crank. There being five cylinders, the power strokes are in perfect rhythm. After the motor is started the timer case is swung around to the left which advances the spark to its maximum. No further attention is required. The variable compression takes care of the proper firing.

The same shaft that turns the timer-wheel revolves by worm gear the force-feed oil pump. This is a very simple and positive device having four little cam-actuated plungers each of which pumps a drop of oil at each revolution of the pump barrel.

The rectangular block shown at the top, which is clamped to the upper tube not only forms a support to the upper end of the crank-shaft, but forms an oil tank for ½ pint of lubricating oil. It also supports the distributor, timer and oil pump, while in the top end is formed the carbureter with float-feed chamber. This complete device weighs only 2½ pounds.

The two motors shown in the photograph are now being used by a well known inventor who is making secret tests of a new type of aeroplane. If these tests result as favorably as might be expected in consideration of the remarkable advantages possessed by the motors we may see a practical "heavier-than-air" flying machine this summer.

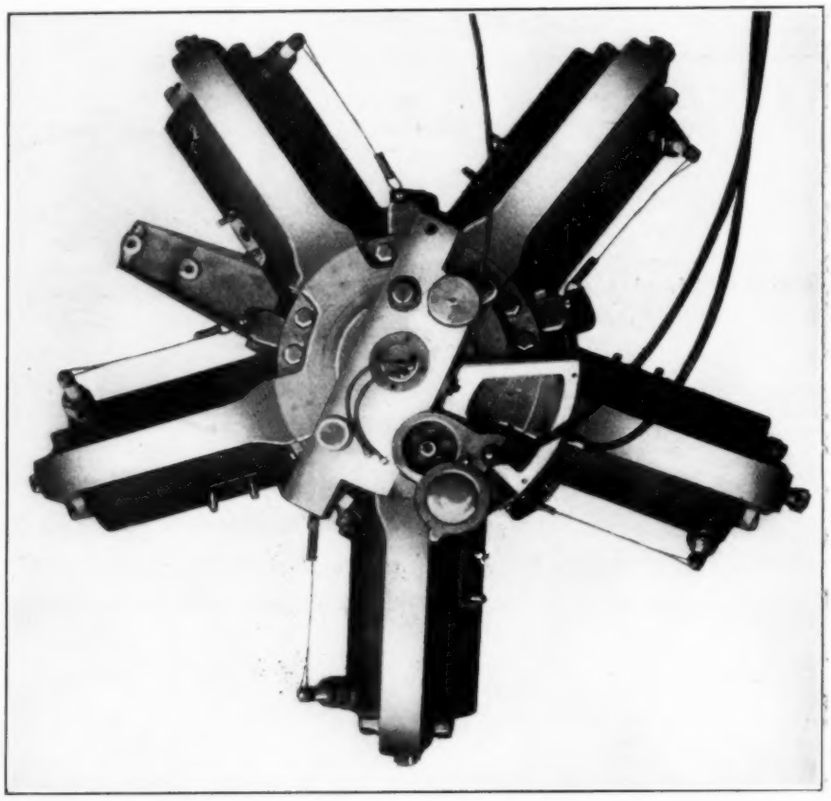


FIG. 3. TOP VIEW OF 5-CYLINDER ENGINE

How to Find, without Mathematics, Spur-gear Cutters for Cutting Spiral Gears

By A. E. Larsson

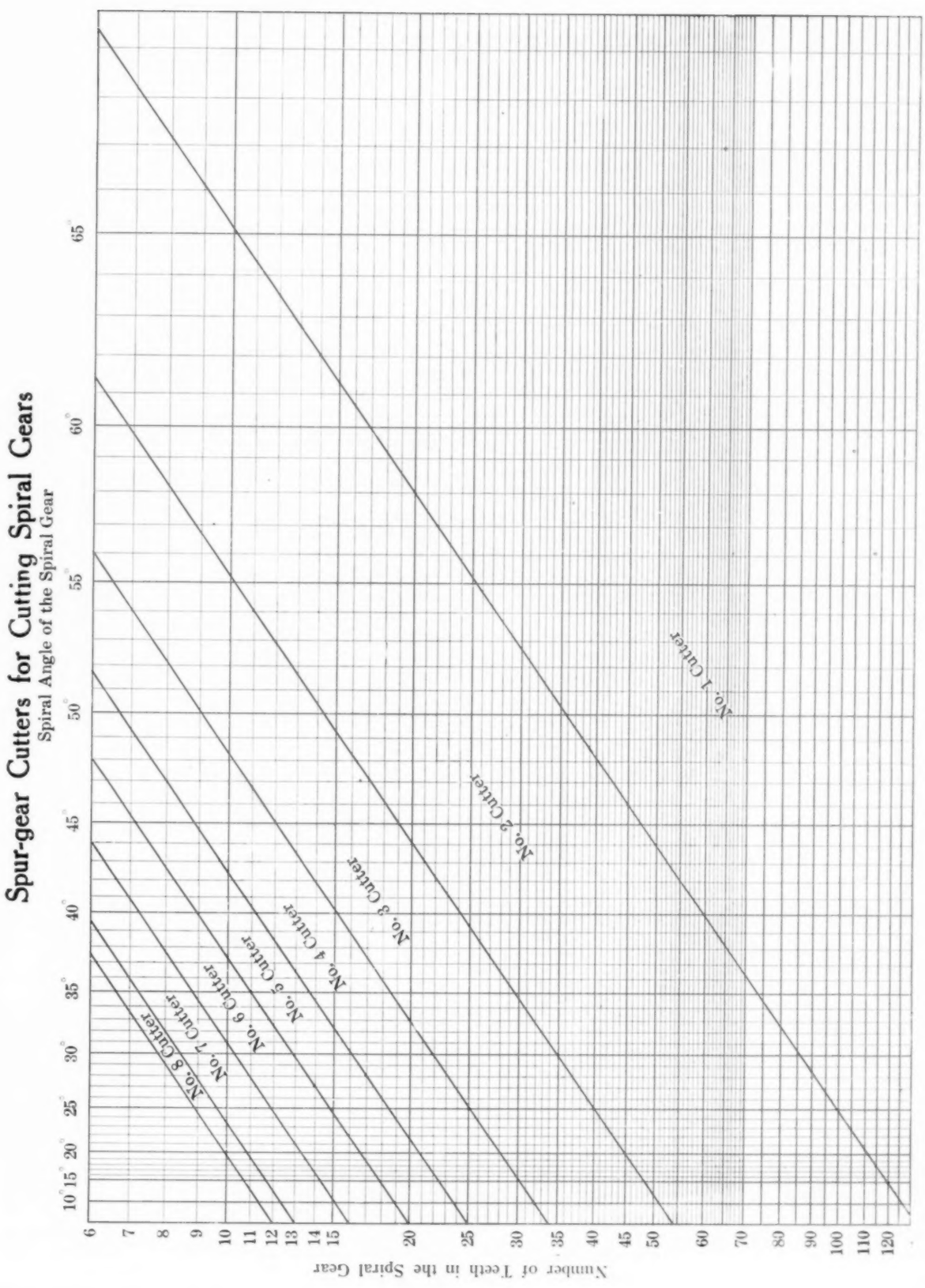
The accompanying chart, printed as a page insert, solves without mathematical computations the problem of finding the proper number of a spur-gear cutter for cutting spiral gears. It refers to Brown & Sharpe involute cutters for spur-gears. The spiral angle is taken as the angle which the tooth makes with the axis of the gear.

The equation from which the chart is plotted is the familiar one,

$$C = \frac{N}{(\cos.\ \alpha)^3},$$

in which C is the number of teeth for which the corresponding spur-gear cutter is to be selected, N is the number of teeth in the spiral gear and α is the spiral angle of the spiral gear as explained above. The chart is arranged to give the spur-gear cutter number directly instead of the number of teeth for which it is to be selected.

It is noted in the *Brass World* that tumbling small metal goods with steel balls produces a bright surface upon them almost equal to that of buffing. It is extensively carried out in the manufacture of jewelry and similar lines.


Spur-gear Cutters for Cutting Spiral Gears
Spiral Angle of the Spiral Gear
10° 15° 20° 25° 30° 35° 40° 45° 50° 55° 60° 65°
Number of Teeth in the Spiral Gear
6 7 8 9 10 11 12 13 14 15 20 25 30 35 40 45 50 60 70 80 90 100 110 120
No. 1 Cutter
No. 2 Cutter
No. 3 Cutter
No. 4 Cutter
No. 5 Cutter
No. 6 Cutter
No. 7 Cutter
No. 8 Cutter

EXPLANATORY—The scale at the left-hand edge represents the number of teeth in the spiral gear. The scale at the top represents the spiral angle of the spiral gear, or the angle between a tooth and the axis of the gear. The body of the chart represents spur-gear cutter numbers corresponding with Brown & Sharpe's involute cutter system for spur gears. Each cutter number applies to the entire area within which it is written.

To find the number of a spur-gear cutter to be used in cutting a given spiral gear, locate the intersection of perpendicular lines traced from the points representing the number of teeth and the spiral angle on the left-hand vertical and upper scales, respectively. The number in the area on the chart within which the intersection falls is the cutter number required.

The Development of Mechanical Movements

Laying out Metal Parts Accurately by Means of Master Plates Bored to Centers Corresponding to Those Formed in the Machine Frames*

BY J. G. VINCENT†

For a number of years I have used a system of developing mechanical movements which has proved a great time saver and has also been the source of considerable satisfaction by enabling me to get a good, workmanlike job turned out on short notice without the usual tedious detail work. While this system may be old, I have never heard of it being used, at least not to the same extent I have carried it out, and as I have had a great many favorable comments from practical men to whom I have explained the system, I think a description of the manner in which it is used may prove interesting to many readers of the AMERICAN MACHINIST.

This system of developing mechanical movements by the use of master plates is nothing more or less than laying out work directly on the metal in much the same manner that a draftsman would lay out the work, considering that the master plate of the machine represents the draftsman's layout. In designing and building attachments or improvements to a standard machine it is, of course, the policy of the designer to change the standard machine just as little as possible without sacrificing the mechanical construction of the new parts. It is, therefore, seldom that the standard centers in the machine are changed except by the addition of new ones, and this being the case, it is usually a problem of so designing the parts that they will work in harmony with certain existing movements already in the machine.

THE OLD "CUT-AND-TRY" METHOD

Years ago a great deal of the mechanical designing was carried out by what is known as "the cut-and-try" method, that is, the parts were roughed out by the workman with the idea of getting them about right, after which they were tried out in the machine and then altered and tried out again, this being done until the part was so shaped that it would perform its work satisfactorily. While parts could be shaped in this manner to perform the work required of them, it was at best a crude method, and has been almost entirely superseded by more up-to-date methods, that is, a thorough designing of the parts on the drafting board before putting the work into the machine shop. Any competent designer who has had practical experience will agree that the latter method is the only one by which a perfect complete machine can be worked out, but in my work, which consists largely of working out many new attachments to a thoroughly standardized machine, I felt the need of a quicker and more direct method of working out the details of experimental attachments and in arriving at a plan to accomplish this result proceeded along the following lines:

THE DESIGNER'S LAYOUT

When a designer starts in to lay out the mechanism of a new attachment for a standard machine, he first lays out on his paper those standard centers of the machine which have to do with the operation of the new device, and he will also lay out and indicate the movements of the several parts with which the new mechanism will have to coöperate. Some of these centers may be in the main side-frame of the machine, part of them in sub-side-frames within the machine, and again these centers may be in individual details carried within these side-frames. After he has these centers carefully located, it is a comparatively easy matter to design the new parts to coöperate with the movements of the old parts, as all of the working centers are on the flat sheet where they can be scaled or calculated accurately. Unless the designer is supplied with a very elaborate set of layouts, however, it might very well happen that it would take him longer to accurately plot the operation of the old parts of the machine than to design the new parts involved.

THE MASTER AND SUB-MASTER PLATES

Reasoning along these lines I decided first to construct a substantial master plate and locate therein all of the centers contained in the main side-frames of the machine, the sub-side-frames located within the machine and also all the important holes contained within the basic operating parts of the machine. This master plate was made about ⅜ inch thick and ribbed on the bottom to bring it up to about 1½ inches in thickness, the bottom of these ribs being provided with feet which were carefully machined and scraped to a surface plate after the casting had been thoroughly annealed and seasoned. The top of the plate was planed perfectly flat while the edges were squared up and scraped to facilitate setting the plate up on edge in taking measurements. The holes were bored in the plate, care being used to locate them as near to figures as possible, after which they were bushed to a uniform size of ¼ inch to facilitate the use of plug gages. In cases where one hole overlapped another, a sub-plate was arranged, such plate being located by first locating two holes in it which registered with holes in the main master plate. This sub-plate was then located on the main master plate by using plugs in these holes, after which the extra holes in question were bored in the sub-plate and properly bushed. After this was completed I had a flat surface containing all the holes in the machine and in order to facilitate the explanation of the method of using this plate I will refer to Figs. 1, 2 and 3, which I have prepared to illustrate this work.

THE PROBLEM TO BE SOLVED

Let Fig. 1 represent the main shaft centers in the main side-frames of a machine, *A B C D* and *L* being the shafts. In Fig. 2, *H* represents a sub-side-frame within the machine carried by shafts *B* and *C*, it being understood that such sub-side-frames are carried on shafts having bearings in the main side-frame at *B* and *C*. These sub-side-frames carry centers *E F* and *G*, as indicated. *I* represents a double-ended arm pivoted at *G* on center *G* of sub-side-frame *H* and in the normal position of the machine occupies the position shown in Fig. 2, or, in other words, with the center of its roller *J* 0.875 inch to the right of the vertical center line. In the operation of the machine let us suppose that movement is imparted to this arm *I* carrying its upper end to the left of the center line 0.875 inch, or an amount equal to the position it normally occupies to the right of the center line. Let us assume it is desired to design a detent latch to position accurately the roller *J* in each of these positions and lock it there during certain portions of the operation of the machine.

APPLICATION OF THE MASTER PLATE

Fig. 3 represents the master plate as it will appear if it has been properly prepared to cover the conditions existing in this imaginary machine. This master plate contains the centers *A B C D* and *L* of the main side-frames, centers *E F* and *G* of the sub-side-frames, also the centers *J* and *K* of the double-ended arm *I* in both its normal and extreme position. With this plate complete we are now ready to make the detent latch *M*, also its lock-plate *N*. Either one of these parts could be made first, but it will prob-

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†Superintendent of Inventions, the Burroughs Adding Machine Company.

ably be better to make the lock-plate *N* first and properly mount it on the pivot stud at the center *D*. In commencing work on the detent latch *M*, the center *L* is first drilled and reamed and then the length of the lower arm is determined and the hole located and drilled to carry roller *O*, which is properly mounted on a stud riveted in place. The detent latch *M* is now mounted on a stud placed in center *L* and the roller *O* drawn up in close contact with the radial surface of lock-plate *N* and the detent latch *M* rigidly clamped to the master plate to hold the parts in this position. The master plate is now turned upside down and used as a drill jig to locate holes at both centers marked *J*, such holes being drilled and reamed to the exact size of the outside diameter of roller *J* carried on the upper end of arm *I*.

Finishing the Work

After this has been done all that remains is to lay out the general contour of latch *M* and file to the lines. In finishing the V's which engage the roller *J* it is only necessary to file them to the angle desired, being careful not to file to a point beyond a line tangent with the outside of the holes already drilled and reamed. Developing the piece in this manner absolutely insures that the roller *J* will be locked with the same tension when in either position, and if developed in the manner described, it will be locked without any particular strain on the parts, but without lost motion. If, however, it is desired to lock the parts under a slight strain, it is only necessary to use a slightly smaller roll at *O* when setting up the parts to drill the centers *J J*, it being, of course, understood that the standard sized roll will be substituted before putting the parts into the machine.

A little study of the drawings will show why I chose these plates to illustrate the principle involved, as it will be seen that while the detent latch and the lock-plate are located in the main side-frames of the machine, the latch *M* must coöperate with the pivoted member located on the sub-side-frame of the machine, which in turn is located on shafts carried by the main side-frames of the machine.

Advantages of the Master-plate Plan

In a case of this kind, even though the part had been carefully laid out by the designer and accurate detail drawings made and supplied to the workman, it would take a great deal longer to make the pieces from the detail drawings than it would take to develop them in the manner above described, this being due to the fact that in order to work properly the working points of the pieces would have to be made accurate to within 0.001 inch, which, of course, would mean some accurate work with the hight gage and micrometer. Much would also depend on the skill of the workman, while by the method above described, a very ordinary mechanic can turn out a perfect job.

While, of course, the case above described is comparatively a simple one, it is intended only to illustrate the principle involved, and I believe it will be readily seen that this idea can be carried out and elaborated upon to almost any extent with profitable results.

Another very valuable feature of this plan is the perpetual check it gives on the standard parts of the machine, for if the

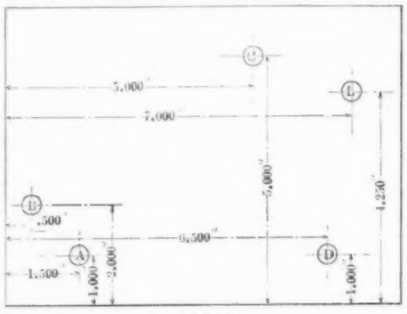

FIG. 1

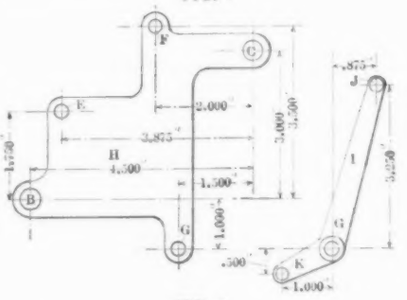

FIG. 2

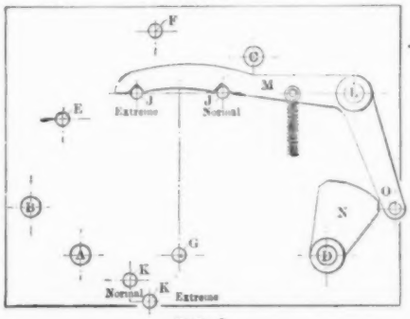

FIG. 3

DEVELOPING MECHANICAL MOVEMENTS BY THE AID OF MASTER PLATES

plate is properly constructed in the first place, it will remain reasonably accurate for years and any of the important parts of the machine can be instantly checked for variations in manufacture by simply matching them up with the master plate and plugging the important holes.

Care of the Master Plate

The master plate should, of course, be handled by mechanics who have some idea of its value and will, therefore, give it reasonable care. It is also desirable to provide a strong cabinet in which to keep the master plate when not in use, fitting this cabinet with drawers in which the special plugs and sub-master plates may be kept.

I don't wish to be understood as recommending this method of developing mechanical details in preference to first making drawings in all cases; in fact, I am a firm believer in the originating of new machines in the drafting room as I believe that is the place to thresh out the many problems arising in the designing of new machines, but where many attachments and improvements are being made for a standard machine, I know a great deal of time can be saved by the method I have just described. After the parts have been worked out by means of master plates and it is finally decided to adopt the improved mechanism, it, of course, becomes desirable to make detail drawings. The making of these detail drawings is an easy matter, as the parts have already been made and the working points accurately located to known points on the master plate, and it is simply a matter of copying the principal figures from known dimensions and supplying such additional figures as become necessary, these additional figures usually pertaining largely to the outside contour of the parts.

Welding Cast-steel Wheel Centers

By H. L. Burrhus

Severe winters are very hard on cast-steel wheel centers of locomotive driving-wheels, and we have adopted the following method of repairing the spokes, and thus saving the expense of a new wheel center.

If the spoke is only cracked, we simply swedge the crack open and weld in a V-piece on both sides of the spoke. On account of such close quarters to hammer our weld at first, it was almost impossible to make a good weld, and then another thing to be considered was that we had to weld wrought iron or soft steel to cast steel. After trying several ways we found that we could get the best results by first welding a thin piece of iron, ⅜ or ½ inch thick to each side of the V we had swedged in the spoke, and then welding in our V-block. Of course, we had to make a weld to each broken spoke, but we get such good results and save so much on wheel-centers that I think the job warrants the trouble.

The only secret of the job is in the welding of the thin piece of iron to the cast steel first. In using the thin piece of iron, it gives the blacksmith a good chance to use his hammer and flatter and thus make a good weld in such close quarters, and when it comes to making the last weld or putting in the V-block, it is simply welding wrought iron to wrought iron and a few blows under the steam hammer makes a perfect job.

I have seen a piece 8 inches long put in the second spoke from the crank-pin hub, on a 50-inch wheel-center, and such a nice job made that the wheel was pressed back on the axle, the crank-pin pressed in and the tire put on and not a bit of machine work done to the wheel.

The First of the Spur Gear Hobbing Machines

Spur Gears Were Hobbed over Twenty Years Ago and a Patent Issued on the Machine Herein Illustrated—Original Machine Still in Existence

EDITORIAL CORRESPONDENCE

The hobbing process for cutting spur and spiral gears has been discussed to a considerable extent in the technical press during the last six months. Some of this discussion has related to the historical development of the art. More, however, has touched upon the development of new machines which use the hobbing process for spur gears. During the last two years some half-dozen such machines have been placed on the market in this country and in England.

Thus, it is opportune to describe the first spur-gear hobbing machine made in this country, and to consider the advantages of the art as they were seen by the original inventor, George B. Grant. Our first half-tone illustration, Fig. 1, shows the original machine upon which Mr. Grant hobbed spur gears some 20 years ago. The original hobbing attachment which he used has been replaced upon the machine, as far as it was possible to do so in order that it might be photographed for this illustration. The hob shown is a hob which was used during the original experiments. Fig. 2 shows this hob and a spur gear which was partially cut by it at the time of the original experiments. Fig. 3 shows a hob and freak gear which were cut at about this time, but not by Mr. Grant. It shows the result of using a hob of too coarse pitch for the number of teeth and size of gear which were to be cut.

A patent application on this machine for hobbing spur and spiral gears was filed in the name of Mr. Grant as inventor on Dec. 12, 1887. The patent itself was issued on Jan. 11, 1889. Figs. 4 and 5 are reproduced from this patent specification and will be referred to in describing the mechanism of the machine. As we have stated, the attachment as replaced and photographed on the original machine is incomplete.

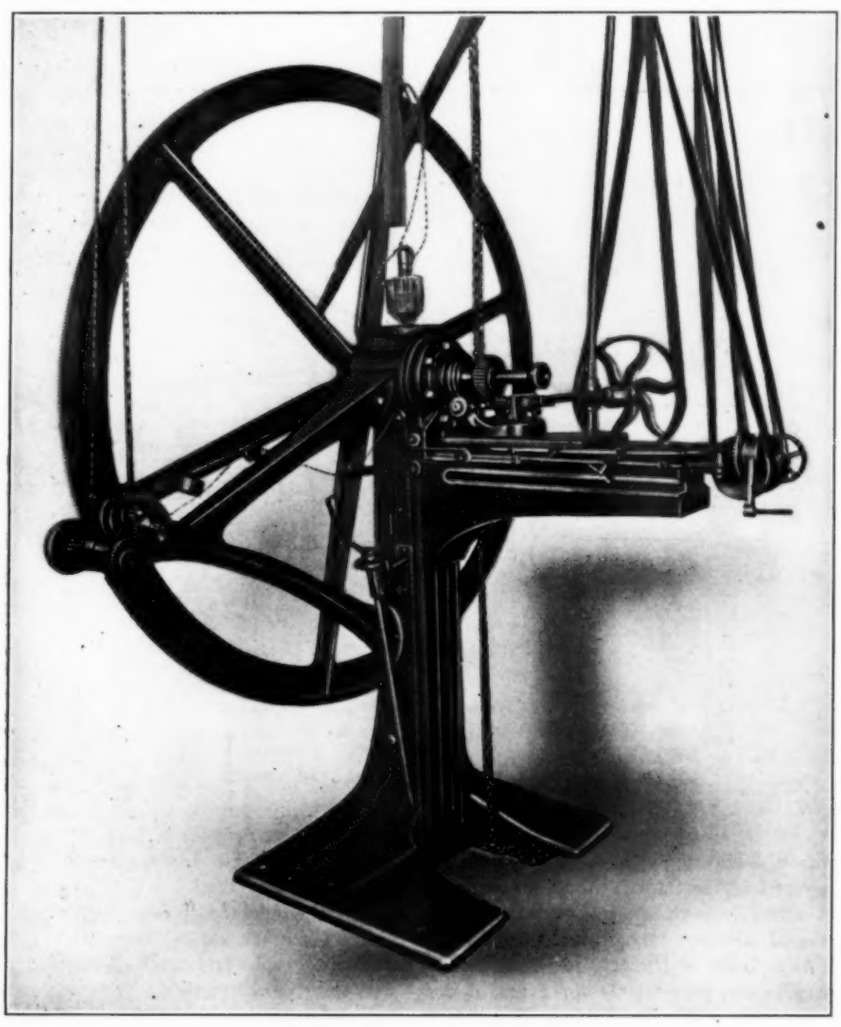

FIG. 1. THE FIRST SPUR GEAR HOBBING MACHINE

Description of the Machine

Referring to Figs. 4 and 5, the gear blank *C* is carried on one end of the gear spindle *B*. On the other end is the dividing wheel *D*, meshing with a small driving pinion *H*. In front of the column at *R* is a stop for the gear blank. The gear spindle *B* is free in its bearings so that it can have a limited amount of end travel. In order to take up this end play and keep the blank *C* against the stop *R*, a spring *O* is introduced between the back of the machine column and the master wheel or master gear *D*.

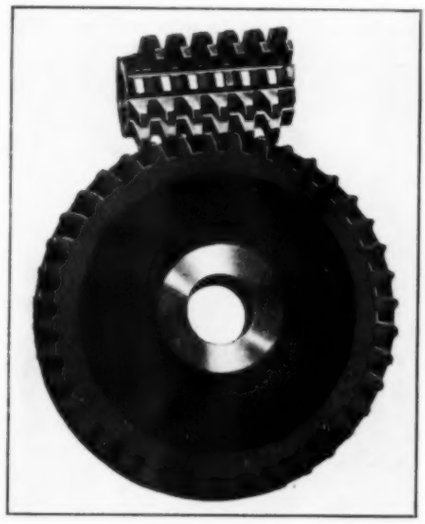

FIG. 2. A HOB AND PARTLY CUT SPUR GEAR

The hob *L* is carried on a spindle in the frame *M*, which in turn is carried on the table *I*. This table is pivoted at the point *K* on the frame *F*. This swinging movement is used in setting the table for cutting spiral gears. As shown in Fig. 5, it is so set. The frame *F* is, of course, adjustable in a vertical direction, in order to adapt it to various diameters of gears within the range of the machine.

The drive is from the pulley *Q* on one end of the hob spindle. Geared from this spindle is a splined shaft *E*, which transmits motion for feeding the hob across the face of the gear and for rotating the blank during the process of cutting. The mechanism for these two motions is so simple that it does not warrant a detailed

description. The universal joints at *Y* and *Z* permit the vertical adjustment of the frame *F* without in any way affecting the operation of the mechanism.

The language of this patent specification is much more readable English than that of the average specification today. Some of the paragraphs are of interest as showing the method of setting the attachment and inventor's idea of the value of the method. We quote: "The frame *I* is fastened on the bed *F* parallel with the axis of the gear blank. The machine is then started, and while both hob and gear blank are revolving together, the hob is fed slowly across the face of the blank, one passage across the face cutting all the teeth." While the preceding quotation refers to the cutting of a spur gear another refers to the cutting of spiral gears. We read: "If spiral teeth are to be cut, the machine is set up and operated exactly

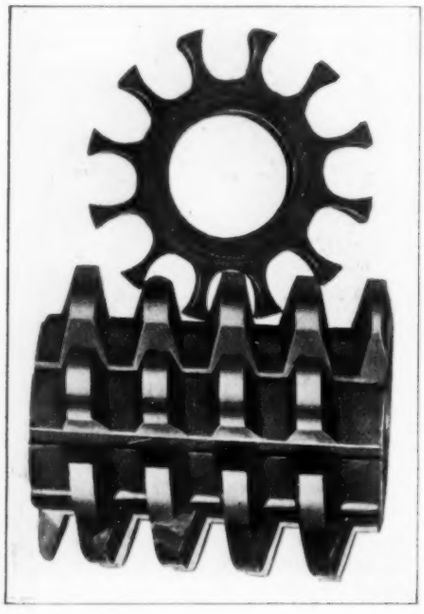

FIG. 3. A HOB AND FREAK GEAR

as for straight teeth except that the frame *I* is then set at an angle with the gear spindle equal to the angle of the teeth to be cut with that spindle, as shown by Fig. 5. If a second spiral gear is cut with the same cutter and the same angle of the frame *I* with the gear spindle, but in the opposite direction, the two gears will run together with their axes parallel."

Some of the advantages are summed up in the two following paragraphs:

"The chief advantage of this method of cutting gears over the ordinary method that employs a single cutter lies in the fact that there are practically from three to six teeth of the cutter at work at the same time, as compared with one tooth by the common process, enabling the required amount of metal to be taken out of the blank in much less time. Much time is also saved by the fact that the spiral tooth keeps steadily at work from the start to the finish, while the common cutter must be returned after it has cut each tooth, and kept away from the blank until it has been spaced for the next tooth.

"The new method also offers the advantage that the teeth made by it are always correctly formed to the size of the gear it is cutting, while the common cutter is made to do duty not only on the size to which it has been shaped, but also on several adjacent larger and smaller sizes. It is difficult to correctly center an ordinary cutter, particularly for gears of few teeth, but the spiral cutter, if straight, does not need to be centered at all. One spiral cutter does duty for all gears from the smallest to the largest, while it requires a set of separate ordinary cutters from 8 to 24 in number to cover the same range. The whole machine is also simpler and more manageable than the equivalent automatic machine adapted to the use of the ordinary method."

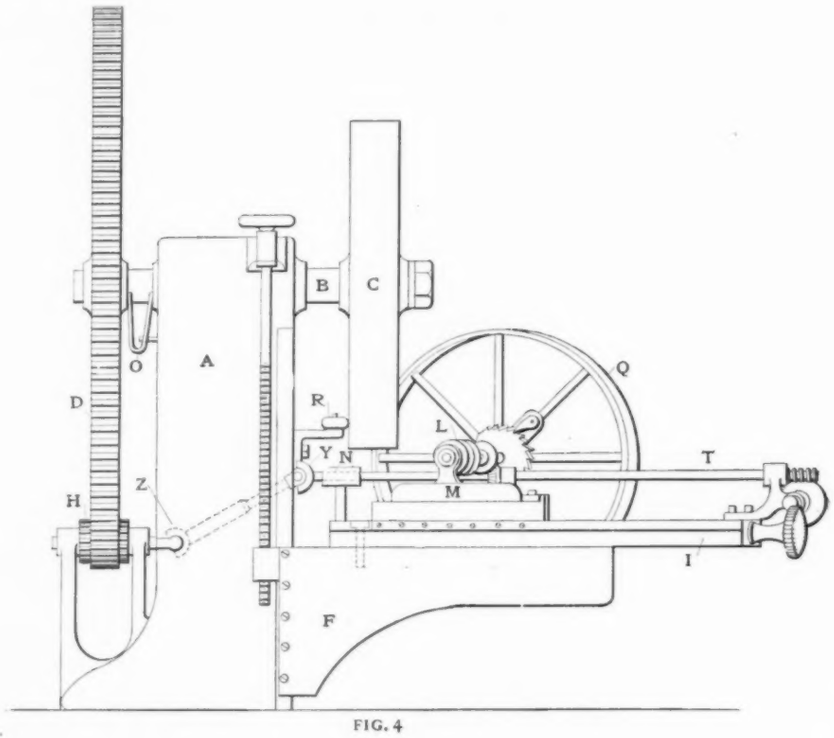

FIG. 4

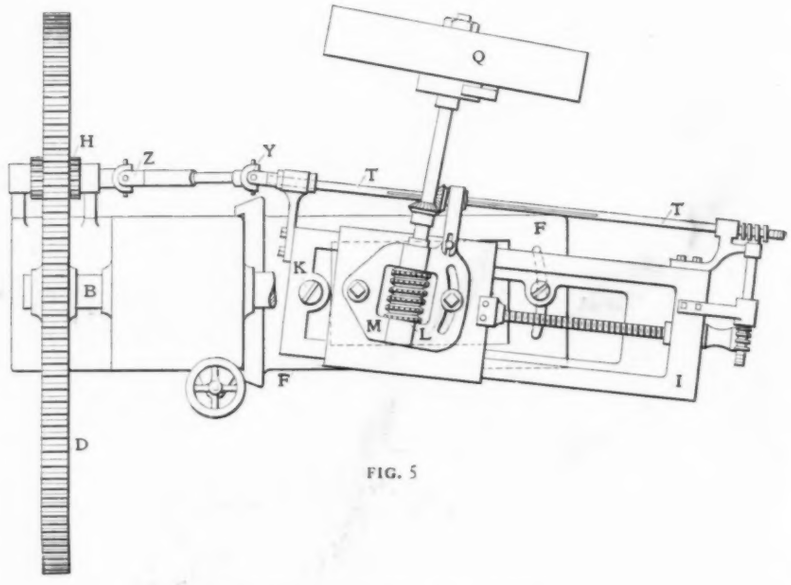

FIG. 5

GENERAL DETAILS OF THE GEAR HOBBER

We are indebted to Mr. Peirce, of the Grant Gear Works, of Boston, Mass., for the photographs and much of the information used in this article. It is a pleasure to acknowledge his courtesy in this connection.

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Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

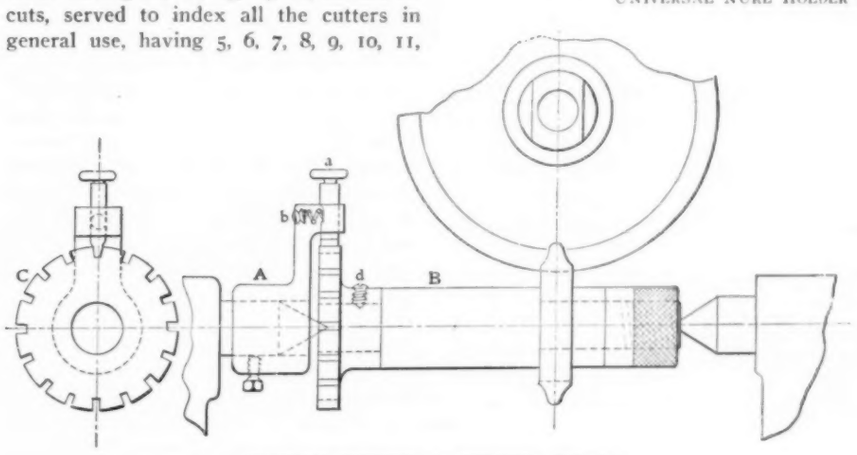
A Grinding Fixture for Relieved Cutters

The necessity of following the advice of milling-cutter makers to "keep cutters sharp" is known, and observed by all who desire best results. Especially is this true with gear and other relieved cutters. The problem is to grind them accurately; by this is meant to make each tooth do its proper share of the work.

For many years we have ground these cutters free-hand, and it was noticed that with a number of men sharpening them, they became *off-radial* and of unequal pitch.

To correct all this, we designed and made the rig here shown. It was applied to a B. & S. No. 13 grinder, but any grinder having centers, and whose wheel arbor could be swung at right angles to center line of table would answer as well.

The part *A* fits on the center in the universal head. In the offset the stop pin *a* is retained by a set-screw and spring *b* as shown. Seven index plates *C* were carefully made having 11, 12, 13, 14, 16, 18 and 20 cuts, served to index all the cutters in general use, having 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 18 and 20 teeth, thirteen in all. These plates fitted on mandrel *B* and were held in place by set-screw *d*. A nurled nut and collars of various lengths completed the fixture.



GRINDING FIXTURE FOR RELIEVED CUTTERS

A thin-dished emery wheel is used. The fixture is cheaply made, simple in construction and quickly applied. It does accurate work, and is preferable to any method where a tooth-rest is used.

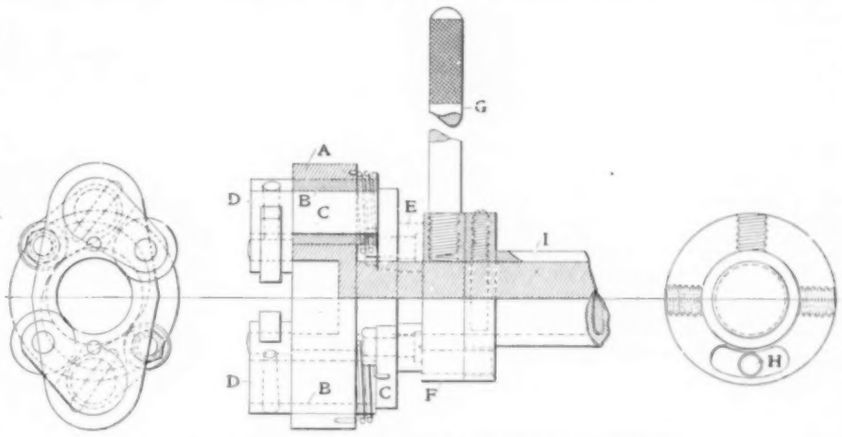
Now our man grinds all cutters of this type, and they stay sharp longer and cut smoother, doing more and better work.

Philadelphia, Penn. H. E. B.

Universal Nurling Tool for the Hand Screw Machine

The nurl holder here shown is designed for operations where the nurls are run onto the end of the work and advanced longitudinally, as in the case of a piece of some length, and also for nurling pieces like thumb screws with half-round edges or work requiring a pattern of nurl which must be fed into the piece toward the center without lateral movement. The movement for the nurls that run on from the end is obtained by means of the turret slide; the movement for the nurls that are run into the work is effected by means of a double-plate cam which is operated by a handle, acting through rock-shafts which carry the nurl-holders and nurls.

It consists of the body *A*, which can be made from a steel casting or forging, or it can be built up from two pieces of cold-rolled steel the piece for the shank forced into the body and pinned. Two hardened steel bushings *B B*, are forced in the body and form the bearings for the rock-shafts *C C*. The rock-shafts and levers which carry the cam-rollers are made from one piece, while the holders *D D*, for the nurls, are made separate and fastened with a good sized taper-pin as the cam having a very gradual rise, great pressure can be put upon the work with very little effort



UNIVERSAL NURL HOLDER FOR HAND SCREW MACHINE

on the part of the operator. The cam *E* is made of tool steel and pinned to collar *F*. Care should be taken to get both sides exactly alike that both nurls may advance at the same rate, otherwise the pressure will be uneven. Collar *F* is drilled and tapped in several places so that the handle *G* can be placed in an upright position regardless of the diameter of the piece being nurled. When the nurl is to be run on work from the end, the handle is removed, a set screw put in the hole and the collar locked in the proper position. This collar also carries a stop pin *H*, which works in a slot in the sleeve *I*, which limits the movement of the handle and also acts as a stop when the nurl is run into the work by operating the handle. Sleeve *I* is provided with a set screw for lightly locking it in the right position, the final locking being accomplished when the tool is clamped in the turret, the sleeve being slotted lengthwise to permit it. Different sizes of sleeves can be used to fit different size of holes in turrets. Coiled springs are provided to push the nurls away from the work when released by the cam. A hole can be drilled through the shank of body *A*, to allow long pieces to be nurled.

With this tool we were able to nurl hard-rubber in a very satisfactory man-

ner, which material was the most difficult of any we tried to nurl.

ELMER A. ERMOLD.

Philadelphia, Penn.

Fixture to Grind Measuring Rods with Spherical Ends

These are understood to be gages made of steel rod ground on the ends, so that these are sections of a true sphere having a diameter equal to the length of the rod.

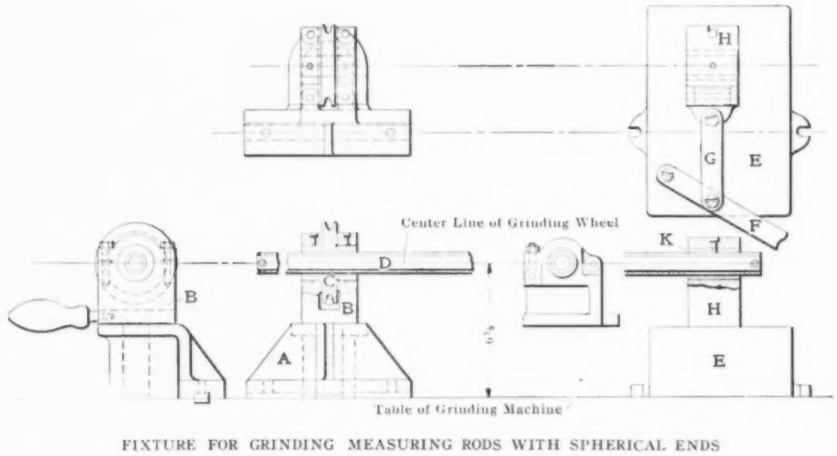
The fixture is composed of a base *A* bored for a pivot. The bore is ground exactly perpendicular to the surface of contact with the table of the grinding machine.

In this bore fits a support *B* forming a bearing and lateral guide for a grooved pulley *C* drilled through so as to fit tight on pieces of Shelby steel tubing *D*. These tubes are provided on both ends with four round-head screws. There are different lengths of tubes, to be used for different sizes of gages, though few are necessary; gages to the length of 20 inches being made with 3 lengths of tubes: 3½ inches, 8 inches and 12 inches. For these gages, the fixture is used as follows: After being hardened and ground to 1/64 inch of the dimension on a plain grinding wheel, the gage is centered in the tube *D* by the screws on each end. With a surface gage it is easy to have the ends the same distance from the pivot center. The pulley *C* is driven by a round belt from the drum driving the work on the grinding machine. Then, by the handle fixed on *B*, the gage revolving slowly, is passed across the edge of the wheel, each end alternately, the combination of these two movements producing a true sphere.

In the case of gages longer than 20 inches, a support for the ends of the tubes is used. This support is formed of a block *E* smoothly finished on top. On it, moved by the levers *F* and *G*, slides the bearing *H*, the hinged cover of which fits on a brass sleeve *K* attached to the tube. By pushing and pulling the lever *F* while the gage is rotating, one again obtains the sphere.

In this case, one end is finished first, then the other is ground to dimensions by moving the table of the machine, the difference with the true sphere being so small that it is not worth mentioning.

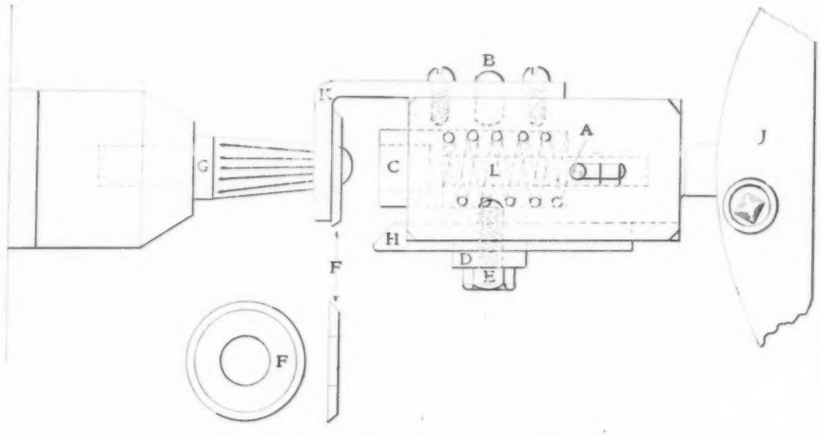
Erie, Penn. P. FENAUX.



FIXTURE FOR GRINDING MEASURING RODS WITH SPHERICAL ENDS

A Tool for Chamfering Washers

The job of chamfering washers, like the one shown by *F*, is not an easy one, that is, if it is desired to do this work with anything like rapidity. It is no easy matter to hold the washer while the chamfering operation is being performed. The tool shown not only helps hold them securely and in proper alinement while being chamfered, but also releases the washer when finished. The body of the tool is made of a piece of 2-inch square machine steel, one end of which has a shank turned on it to fit one of the holes in the turret head of the screw machine, a part of which is shown at *J*. The large end has a hole bored in it central with the shank and large enough to accommodate the tool-steel piece *C* and the compression spring *L*. The piece *C* is also recessed on its large end, the other end being turned down into the form of a stem or shank, the spring slipping over this. A pin *A*, driven through a hole drilled in the shank end of *C*, works in the slot *M* keeping both in place. The recessed end of the piece *C* is hardened and drawn. On the front side of the tool body at right angles to the sides already mentioned a groove or spline is milled, to accommodate the high-speed-steel tool *H*, the top side of the groove being on a line with the center of the recess in the piece *C*, which brings the cutting edge of the tool *H* into proper location for chamfering the



TOOL FOR CHAMFERING WASHERS

washer. The strap *D* and cap screw E, clamp this tool. On the back of the tool body is fastened the stripper *K*, by means of screws and two dowel pins *B*, of which only one is shown. This stripper *K* has a hole through it large enough to permit the entrance of the taper plug *G*, which is fluted all the way around its circumference, by an angular cutter. This plug after hardening and tempering is fastened in the chuck end of the screw machine and serves as a mandrel gripping and holding the work while it is being operated on. The operation of the tool is as follows: The operator takes a washer, slips it in past the tool *H*, the rounded end of which is blunted to prevent his cutting his fingers, in the space between the stripper *K* and piece *C*. He then moves over the tool by means of the hand lever which operates the turret slide. The piece *C* forces the washer onto the plug *G* as far as it will go, the flutes gripping it, revolve the washer. The spring *L*, compressing in the back of *C*, as far as the stop at the back end of the turret slide permits, gives a frictional effect between the face of the piece *C* and face of the washer which compels it to revolve with it under the cut. The cutting edge of the tool, washer and face of *C* are flooded with a good lubricant. The illustration shows a washer with the chamfering operation completed and partly stripped from the plug *G*.

New York. JAMES J. KLEIN.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Co-operative Education

There are two words before which a certain portion of the world bows down in awe; one is Professor, the other is Practical. To one man the word professor is associated with necromancy. A professor to him is a man endowed with intellect beyond the common, an intellect far above considering the minor things of life, an intellect that hob-nobs with the black arts and deals with things that the ordinary mind could not understand no matter how lucid the explanation. Since this deep learning is inexplicable and untransmissible to the practical mind, the professor fails to be of the value to the commercial world which he ought. That is the point of view of one man.

Now for the attitude of the other, who worships the Practical, spelled always with a capital P and usually all in capitals. To this man a practical man is one who does things without knowing why or how he does them. A "practical" bridge builder builds a bridge while the "professor" is studying over plans. A "practical" heating engineer looks over a house and says, "put a radiator here and one there, set the boiler here" and, presto! the thing is done while the professor is figuring areas of glass and factors of exposure and square feet of wall space. Again the "practical" man is one who has "learned" his trade from someone else who learned it, etc. Therefore, he is a man who knows he is right because someone else did the same thing years ago.

Practicalizing the Professors

Now Professor Schneider, of Cincinnati, is trying to get the professor to bump heads with the practical man. He is trying to make both of them roll up their sleeves and do their stunts in the open where everyone can see how they are done. No longer is a college professor to be allowed to do his little tricks with a marked pack in every pocket. He must stand for a reverse quiz, which means that his pupils can ask him questions about the same thing that he is teaching. Professor Schneider says that several instructors have resigned rather than be shown up. To be sure we suspect that these striking questions emanate from the shops where these students are spending most of their time and are "stickers" passed out by the foremen for the boys to have "high jinks" with. We suspect that most of these questions are as unanswerable and about as important as "who has the left-handed monkey-wrench?" If the instructors do not know when they are being asked monkey questions it is time they got out.

The Professor and "Practical" Man Should Get Together

There is certainly need that these two factors of progress should get together and discover each other's point of view. From the other's standpoint the professor leaves his work half done; from the professor's point the practical man only half does what he attempts. For example: I have been trying to design a hydraulic-pressure cylinder. I looked up formulas and picked out one that originated less than a thousand miles from the University of Cincinnati. I figured the thing through and, lo and behold, the inside diameter of my cylinder proved to be larger than the outside, nor could I reconcile the figures with common sense until I went through the whole reasoning of the proof and discovered that for the sake of getting an easy mathematical demonstration the author had taken the internal pressure as negative. Reversing the sign of my applied pressure I found my cylinder right side out as it should be. A practical man would have finished off his job so that the formula could be used by anyone not in the secret.

I found another formula in a practical handbook and it gave results nearly correct (as compared with the professor's) over a limited range of inside and outside diameters, but for a considerable difference of diameters it was manifestly wrong. Now the professor would say that the practical man did not half do his job since the formula was special, not general. A professor is finicky; a practical man is slack. A shop acquaintance of mine used to say that a shop man went "by guess and by thunder, and by thunder it's wrong." Other than these things the only difference between a professor and a practical man is in the frequency with which each has his trousers pressed.

Comparison of Hours of Instruction

To get back to Professor Schneider and his coöperative school: The name is one that I dreamed out a few years ago and some of the details seem familiar to me. Perhaps I might be expected to find nothing but unalloyed satisfaction in contemplating the result thus far. I do feel, however, that the real virtues of the scheme have been kept concealed and others advanced in their place.

To begin with, averaging the hours in the technical courses of seven leading schools of this country we find 7125 hours of work required of students in a four years' course; of this time an average of 650 hours is devoted to shop work. The coöperative course at Cincinnati calls for, allowing as in the averaging above for two hours' study per recitation, only 4640 hours outside of shop work, and distributed over six years. It does call, however, for vastly more shop work. This shop work is not the intensive work under the eye of an instructor as is the other schools. It is actual productive work under conditions hardly different from those imposed on apprentices in any wide-awake shop. The employers of these boys are said to find that it pays to have them at the 10- or 11-cent per hour rate which they are "allowed" to pay. These boys should be educated to become engineers, not merely machinists.

Advantage to the Shops

The only good that most of these Cincinnati shops can hope to get from the boys is what they can make out of them as they go along. After they graduate they are quite as likely to come into competition with their former employers, as into coöperation. There is but little room for doubt that with, as Professor Schneider said, 2000 boys to select from and a chance to weed out 1900, the remaining 100 boys are of the stuff that could earn 10 cents per hour twice over with very little training. Last summer a prominent Eastern concern was glad to pay 25 cents an hour to technical school men who had had only about 150 hours experience in machine-shop work. From the shopowner's point of view it is ideal.

Advantage to the Students

Now let us look at it from the point of view of the student. Under former conditions, unless he had some capital, it seemed an almost hopeless task for a young man to get an engineering education. The old line college was hard enough, but the engineering curriculum calls for much more work and much more attendance at stated times, thus largely cutting down the time available to earn one's way through.

The methods which may be used to earn a living at odd times are precarious. The substitution, for men, working their way through, of a steady reliable wage of even half what they are worth is like a life preserver thrown out of a fog. That to the writer's mind is the real ad-

vantage of this coöperative scheme; it gives students a dependable method to earn their way through school, even if its results are meager. So far as this is concerned it seems as if it mattered little whether the work was in machine shops or in places entirely unallied with the engineering profession. It is the money only that appeals to me.

The boys who go to these shops must of necessity be put on repetition work, no purely instructive course is possible. The boys are associated with, and are under, men whose principal aim is to get out work and to whom every break in their regular routine to show someone else is necessarily disagreeable. The duties of instructor and foreman do not mix better than oil and water. In the greatly increased number of hours devoted to shop work these picked boys undoubtedly do pick up as much of the underlying principles of their work as if they had a good school-shop course, and, of course, must become vastly more expert. This latter accomplishment, it is to be hoped they will not have to use, since they are being trained for engineers. In the meantime even if under-paid they are necessarily much better pleased than not to have the chance at all.

The advantage is all with the beginning of the thing. When, as is likely, other schools take up with it, this having 200 applicants from which to select 30 to stay one year will end, and when the scheme is applied to the 30 least desirable ones the 10 cents per hour rates will be entirely too high for the shops to pay.

To my mind this is a thing that would work better with a trade school than with a technical college; in a trade school proficiency in shop work is an essential. Even in that case I would recommend that instead of a flat rate the premium system be used as a safeguard to the shops and as a "square deal" toward the students.

Fitchburg, Mass. ENTROPY.

Casting One Metal on or in Another

Referring to the article by W. H. Brewer, on page 621, asking for information on how to cast hard-brass rings into a cast-iron center; I judge he means to pour the cast iron around the hard-brass rings; if so, it can be done very easily by treating the rings as cores, correctly setting them in position, and pouring the cast iron around them. The one careful point to be observed is that the "temper" of the metal should be just right, that is, it should be just soft enough to pour and run.

Casting one metal into another has been advantageously done, and with very little trouble. I recall to my mind several, one a cast-iron rod which was subject to little twisting force, but a large tensile force that would break the bar if the load happened to increase beyond that assumed. The sectional area of the bar could not easily be increased, and the design on one end did not recommend the use of cast steel, so we cast a square wrought-steel bar in the center of the cast-iron bar, and let each end of the wrought-iron bar project out beyond the casting, enough to permit it being riveted over; this addition stopped all trouble.

Providence, R. I. O. JAMES.

Piston Rings of Uniform Strength

On page 723 there is a query by W. Osborne about the shape of a packing ring which should give a uniform normal pressure over its entire face. The following approximate solution may be of interest.

A packing ring, Fig. 1, cut at Q' is held closed by the action of a uniform pressure F normal to its exterior cylindrical surface. Its breadth a and thickness b are assumed to be small in comparison with its radius r'.

Then at P'

$$\frac{d\,(\vartheta' - \vartheta)}{d\,s} = \frac{8}{a\,b^3\,E}\,M,$$

where M is the bending moment at P', and E Youngs' modulus for the material.

Also,

$$M = F\,a\,r'^2\left(1 + \cos.\,\frac{s}{r'}\right).$$

$$\therefore \frac{d\,(\vartheta' - \vartheta)}{d\,s} = \frac{1}{r'} - \frac{1}{r} = \frac{8\,F\,r'^2}{E\,b^3}\left(1 + \cos.\,\frac{s}{r'}\right),$$

and

$$\frac{d\,\vartheta}{d\,s} = \frac{1}{r} = \frac{1}{r'} - \frac{8\,F\,r'^2}{E\,b^3}\left(1 + \cos.\,\frac{s}{r'}\right),$$

where r is the radius of curvature of the ring when open. By assigning b^3 some value as a function of s the equation can be integrated in ϑ and the intrinsic equation of the curve obtained; but in general this leads to results too complicated for convenient use.

If the ring is to remain circular when open r is a constant, and therefore b^3 varies as $\left(1 + \cos.\,\frac{s}{r'}\right)$. This, however, is not a practical construction because the thickness at Q is zero, Fig. 2.

If the thickness b is to be uniform, the following graphic approximation may be used. With s as abscissa, Fig. 3, draw

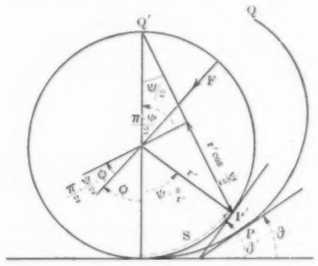


FIG. 1

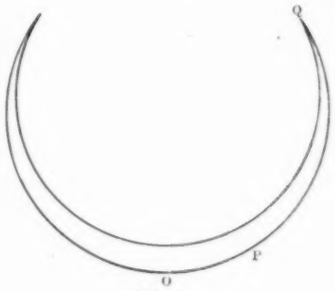


FIG. 2

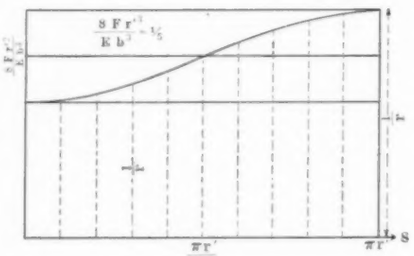


FIG. 3

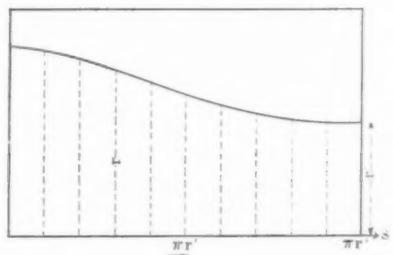


FIG. 4

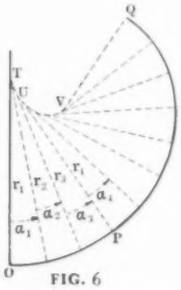


FIG. 6

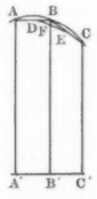


FIG. 5

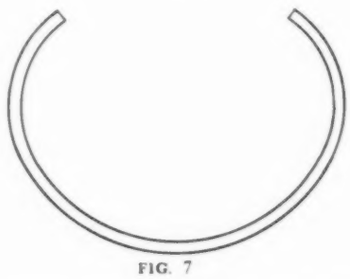


FIG. 7

DIAGRAMS ILLUSTRATING THE LAYING OUT OF PISTON RINGS OF UNIFORM STRENGTH

a negative cosine curve with $\frac{8 F r'^3}{E b^3}$ as amplitude. Draw a zero line a distance $\frac{1}{r'}$ below its highest point. The ordinates thus obtained give $\frac{1}{r}$ (This can be obtained almost as readily from a table of cosines). Measure a sufficient number of these ordinates and from a table of reciprocals find r and plot the values against s as abscissa, Fig. 4. The minimum value at $s = \pi r'$ is, of course, r'. Divide this curve into a sufficient number of equal parts, say 10, and find for each the average ordinate. This can always be found with sufficient accuracy as follows: Let $A\,B\,C$, Fig. 5, be the portion of the curve with B its middle point. Draw the chords $A\,B$ and $B\,C$. Take D two-thirds the way from A to B and E two-thirds the way from C to B. Draw the straight line $D\,E$. Its intersection F with the vertical line $B\,B'$ gives with sufficient accuracy the average ordinate of $A\,B\,C$. (The work to this point can also be carried out by simple numerical approximations).

For each of these values $(r_1, r_2, r_3 \ldots.)$ calculate $(a_1, a_2, \ldots.)$ by the formula

$$\alpha = \frac{r'}{r} \cdot 18 \text{ degrees } (18 \text{ degrees} = \frac{180^\circ}{10},$$

10 is the number of parts in which the curve is divided) and lay off the curve $O\,P\,Q$ as shown in Fig. 6. The appearance of the ring is shown in Fig. 7. The broken line $T\,U\,V$, Fig. 6, is evidently an approximation to the evolute of $O\,P\,Q$. It would be much easier to draw $O\,P\,Q$ if this evolute were known, but its equation comes out more complicated than that of $O\,P\,Q$ and there seems to be no simple graphic method for its construction. A larger number of parts will, of course, give more accurate results.

This graphic construction may readily be modified to apply to any problem involving a known variation of the thickness b, as for example the construction which will give the same stress in the outer fibers at all points of the ring, or the same factor of safety against breaking strains at all points.

The determination of the errors involved in the assumption of small cross-section would require more complicated calculations. I do not think that the errors will be large in any practical case.

A wire passed around the ring would give a uniform normal force if there were no friction between ring and wire. With friction the normal force would in general be variable but its variation cannot be calculated as it depends upon the manner in which the wire was placed on the ring. It makes a difference, for instance, whether the ring is first closed and the wire then adjusted, or the ring is closed by tightening the wire. Nearly uniform forces can probably be obtained by turning the ring in the loop of wire after it has been tightened.

Lincoln, Neb. L. B. TUCKERMAN.

The article by W. Osborne on page 723 has attracted my attention. A piston ring conforming to the formula for a beam supported at one end and uniformly loaded cannot be readily manufactured without special tools. The profile of such a beam is made up of two parabolas. An approximation as shown by Mr. Osborne may be made by turning the outside of the ring eccentric with its bore.

Now, a ring made comformable to the formula for a beam of parabolic profile will have twice the deflection of a ring of uniform section. (Trautwine, page 486, paragraph 77). Hence, to get a ring of the same deflection as one of uniform cross section it must be turned to a larger diameter, otherwise the stiffness and corresponding length of useful life of the piston ring is greatly diminished.

Believing the chief aim of Mr. Osborne is to make piston rings that are round and

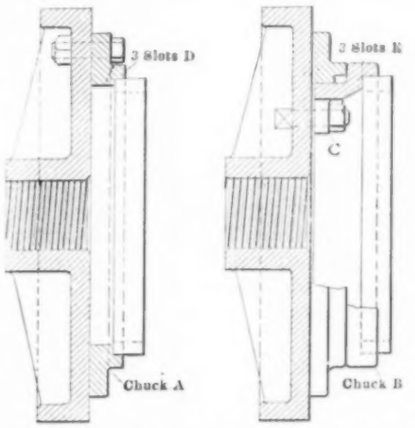


FIG. 8. CHUCKS FOR FINISHING PISTON RINGS OF APPROXIMATE UNIFORM STRENGTH

fit in the cylinder, and presuming that he is making them in such quantities as to warrant the making of fixtures, I have a method to suggest. This method will not be attended with the uncertainties nor the amount of experimental work of that discussed above. It will require that cylinders of a given nominal diameter shall be of uniform standard bore, and that rings shall not receive a permanent distortion in placing them on the piston.

Take a flange, face it and bolt it central on a face plate, using a couple of small dowels to insure against moving. Then bore it out to about 1/64 inch larger than the cylinder and face a shoulder at a distance from the outer face equal to about 1/3 of the width of the piston ring. Then bore a second step as shown in Fig. 8. Let us call this chuck A. Now take another flange B, which has three lugs C and face and turn it as shown, so that its smaller step will be an easy fit in the smaller bore of chuck A. Secure it by three T-head bolts, bore it to exact cylinder size and face a shoulder at about one-half the width of the piston ring from the outer face. This may now be removed. Call it chuck B. See Fig. 8.

Take a piston ring that is turned and slotted and force it into chuck A. With a substantial electric center grinder held in the tool post grind the exposed part of this ring to the cylinder diameter. Now press chuck B onto this ring and remove both from the chuck A by inserting a small bar in the slots D. Reverse chuck B with ring and secure in chuck A and grind the remainder of the ring.

Our company makes a friction ring which is just the reverse of this process. A ring is bored, say 3 31/32, and rough turned to a size slightly greater than 4 5/8 inches. The ring is split and sprung onto a mandrel 4 inches diameter and ground to 4 5/8 inches diameter. This secures a ring having a nice bearing in the ring into which it is to be expanded, and when released it does not drag.

R. H. WADSWORTH.

Indianapolis, Ind.

Turning Hard Rubber

I note an article on page 881 pertaining to hard rubber by Mr. Harfmann.

He advocates the use of cyanide on tools to prolong the cutting edge when cutting rubber. A better kink which does not appear reasonable but is true nevertheless, is to make the circular-forming tools for the automatic-screw machine, or other forming or turning tools out of brass. It looks queer to a mechanic to see counterbores, forming tools, etc., made of *brass*, but any reader that doubts the value of this kink needs only to try it. We use as much hard rubber as the next one and we have tried every kind of steel known, but the edge will turn about as quickly with special steel as with ordinary steels. I would ask Mr. Harfmann if he will please inform me how many pieces were made and what brand of steel he uses that will stand two days without grinding?

We have used cyanide with fair results, but could never run two days, indeed two hours would be considered an excellent run. When tools are made of brass it saves considerable time in sharpening as the tool can be filed across the face without removing it. Take a stiff piece of brass and file any profile for a trial forming tool, put the brass in the tool post of the shaper and try it. It is only a few minutes' work and will be the means of overcoming considerable cussing and loss of valuable tools.

FRANK E. SHAILOR.

Worcester, Mass.

Steel or iron articles to be plated, and which come from the machine shop reeking with oil, should first be dipped in benzine to remove as much as possible of it, according to the *Brass World*.

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The Compulsory Working of Patents

We are in receipt of the report of the hearings of the House of Representatives committee on patents, relative to the proposed legislation by which the compulsory working clause is to be introduced into our patent laws, and an examination of it shows that there are two sides of this question, like most others.

Several bills are before the committee, of which, however, but two received much consideration; one of these making compulsory working obligatory upon all patentees, while the other makes it obligatory upon alien patentees only. The latter, of course, is distinctly retaliatory, and while the spirit behind the former is the same, its results would be much more far-reaching. To the general compulsory clause the opposition was substantially unanimous, and while many favored the spirit of the bill aimed at foreign patentees only, the general impression was that, desirable as is its principle, it would in other directions work more than counteracting harm.

The case against a compulsory-working clause applicable in all cases was, perhaps, best stated by W. W. Dodge, who pointed out that when a principle is discovered and developed it may often be embodied in many physical forms, all of which must be patented in order to secure protection, although but one can be commercially worked. In such cases the effect of a compulsory-working clause would be to throw open to competitors the alternative constructions, and thus nullify patent protection and give to competitors the results of expensive development and experimental work.

Mr. Dodge also pointed out the hardships that such a clause would place upon the inventor of small means, who already has difficulty enough in getting his inventions taken up by manufacturers. Such a clause would deliberately encourage a manufacturer to defer taking up an invention until after the expiration of the time limit, when the patent being annulled, he would get the invention for nothing.

One objection to which Mr. Dodge did not refer, and which to us is, perhaps, the most serious of all, relates to patents which, while fundamentally important, yet lack some feature necessary to complete success, which feature is often supplied by a later invention. The result of this situation would be to shorten the probationary term of the original patent by the interval between the two and in many cases the final invention would find the original basic patent annulled, the only protection left being that of the second patent, which, while necessary for mechanical success, might, and often would, be of trifling importance considered as a patentable feature.

Mr. Dodge concluded by saying: "Much as I would like to see some retaliation for the manifest and studied efforts of foreign countries to place obstacles in the way of American inventors, and to secure for their own citizens the benefits of American inventions, I am still unable to see any workable or practical plan by which that end may be obtained. Every proposition that has thus far been advanced, so far as my knowledge goes, involves injury to American inventors, patentees, manufacturers, and the public vastly greater than any benefit possible of accomplishment thereby." This quotation from Mr. Dodge puts in a few words the general consensus of opinion brought out at these hearings.

Referring to the bill in which the retaliatory feature was restricted to alien patentees, it was pointed out that this would be a new feature in patent legislation, since in all foreign countries of industrial importance which have a compulsory clause in their patent laws, this clause applies to their own citizens and to foreigners alike, and it was stated that this feature has been found to be extremely unsatisfactory, especially in Germany, Dr. Alfred Muller saying that he had "no doubt that when the German patent law is revised, which will be the case in the near future, and a new law enacted, it will no longer contain the former provision requiring a patentee to work his invention, subject to the loss of his patent if he fails to comply with said requirement." In this connection it should be remembered that the English law is a new one, the working of which has not yet had time to develop, and it was confidently predicted that it will be found to be so unsatisfactory as to lead to its repeal in the near future. Another speaker stated that the German government had begun negotiations with the English government "with a view of coming to an understanding about the working clause and have it mutually abolished."

Several speakers who indorsed the principle of the bill in which the compulsory working clause applies to alien patentees only as theoretically what the situation calls for showed nevertheless that there is great practical difficulty connected with it, because of its provision that a patent issued to a citizen of a foreign country shall be upon the same conditions and terms as those imposed by the patent laws of the country of which the inventor is a citizen. This provision would make it necessary for the office to issue 116 different kinds of patents for different terms and upon different conditions, and it would enormously complicate the administration and the interpretation of the patent law, which is already complicated almost beyond any other. The determination of all the nice points involved in the interpretation of foreign patent laws would throw upon the patent office an unworkable volume of business.

We gather from the remarks of the chairman of the committee that great pressure is being brought to bear for the passage a retaliatory bill of some kind, and that Congress is ready to pass almost any bill which the committee will report. It is also understood that negotiations are in progress through diplomatic channels to endeavor to bring about a change in European patent laws, with apparently greater prospect of success in the case of Germany than that of Great Britain, this condition growing out of the fact that the German law is the source of much dissatisfaction at home, while the British law has not yet had time to develop its bad features.

One of the strongest arguments against the passage of any of the pending bills was made by the Commissioner of patents, and a committee of the Patent Law Association reported, as the result of an inquiry among his members, that the sentiment of almost the entire patent bar, so far as it can be learned, is opposed to the proposed legislation "not because the idea of retaliation is unsatisfactory, but because it is feared that more harm than good will result from any legislation thus far proposed."

Our own advocacy of this measure has been based upon the obvious need and justice of retaliation against the laws of countries which have worked and are working serious injury to American manufacturing interests. We are as firmly convinced of this as ever, but the statements made at these hearings make it plain that this is a case for making haste slowly. Desirable as is a retaliatory act, it is plain that the bills now pending are defective to the extent that they are a serious menace to the interests of American inventors and manufacturers, and that if retaliation is to be resorted to, it must be on lines materially different from those now proposed. It is at the same time more than probable that a retaliatory measure of some kind will become a law, and it behooves inventors and manufacturers to bestir themselves in order to make sure that the law when passed does not prove to be a boomerang.

We have seldom seen a report of congressional hearings which is so full of forceful and well considered argument as this, and we urge all who are interested in the subject to write to the clerk of the House committee on patents and ask for a copy.

Machine-shop Dividends

What is the idea of the average man in regard to machine-shop dividends? He may have a general and fairly accurate knowledge of the dividend history of the important railroads of the country, and of some of the great enterprises which exploit natural resources, as mines and the like; but it is very doubtful, unless he has made an especial study of the subject, if he has any idea whether the average machine shop pays 5 per cent., or 20 per cent. per annum in dividends. We readily confess to the lack of knowledge that we have indicated. In contrast to this situation we note a leading article in *Technik und Wirtschaft*, a publication of the Vereines Deutscher Ingenieure, the well known German engineering society. This article gives a somewhat extended statistical analysis of capital, dividend, surplus, depreciation, etc., of machinery-building firms, arranging them into nine general groups. The following tabulation gives the dividends paid during the year 1906 in per cent. of the nominal capital for these nine groups:

Groups.	Dividend in Per Cent.
General machinery building	8.4
Locomotive building	9.8
Ship building	9.1
Machine-tool building	9.1
Textile machinery building	13.3
Gas engine building	6.5
Motor vehicles, sewing machinery and vehicles	13.6
Agricultural machinery	10.6
Specialties	10.3

The average dividend rate of these groups is 9.4 per cent.

New Publications

THE TRACING OF DIRECT-CURRENT AND ALTERNATING-CURRENT MOTOR TROUBLES. By E. B. Raymond. 197 pages, 4¼x6¾ inches, 73 illustrations. Hill Publishing Company, New York City. Price $1.50.

Motor and generator troubles are often difficult to trace out and to remedy, for they may have an electrical or a mechanical cause, or one that is a combination of both. In this volume are given in a concise manner the methods which experience has demonstrated to be simple and effective in tracing and connecting such troubles for both direct- and alternating-current machinery. In addition are given the methods of conducting tests to find motor and generator characteristics. The chapter headings are: Starting up; sparking; brush troubles; characteristics of the induction motor; locating faults in induction motors; winding faults; balking of induction motors; mechanical troubles; troubles in synchronous motors; testing generators; testing direct-current motors; alternating-current generators; testing induction motors.

BETTERMENT BRIEFS. By H. W. Jacobs. 240 6x9-in. pages, with 136 illustrations. Crane & Co., Topeka, Kan.

Railroad repair shops are undoubtedly far in the rear of manufacturing shops in point of efficiency, and the volume under notice is a well considered and a well executed attempt to call attention to the possibilities of cheapening the work of railroad shops by the use of modern methods. The author has collected together a large number of examples of improved methods of handling work which are illustrated by both half-tones and line engravings, and many of them are accompanied with figures giving the saving in time accomplished by their use. In a larger way the author advocates the establishing of a central tool room for a railroad system where standard tools shall be made and distributed to the various repair shops of the system. The concluding chapter gives some striking pictures of the recreation buildings which have been erected by the Atchison, Topeka & Santa Fé Railway system for the use of employees. The entire book is extremely suggestive and deserves wide circulation among railroad shop men.

TESTS OF CAST-IRON AND REINFORCED CONCRETE CULVERT PIPES. By Arthur N. Talbot. Bulletin No. 22 of the Engineering Experiment Station of the University of Illinois, Urbana, Ill.

In this bulletin are recorded the results of a number of tests to determine the strength of cast-iron pipes, concrete pipes and reinforced concrete pipes, such as are used for railroad embankment culverts. The investigations were made possible by coöperation of five of the great railroad companies of the middle States. From the results of this experimental work certain deductions are made. We quote: "It will probably be best then to use 1/16 W d for the bending moment coming upon a pipe when the bedding and later filling are well done. The strength of cast-iron pipes may be calculated by using in the expression for resisting moment a value of the modulus of rupture, say, 25 per cent. less than the modulus of rupture obtained by breaking small beam-test specimens of the same material. The effect of the presence of a bell is somewhat uncertain; but it is quite probable that greater strength could be obtained by distributing the metal of the bell throughout the barrel of the pipe. It seems probable, too, that as ordinarily laid in the embankment the thickness of the bell will interfere with the distribution of pressure over the bed and thus reduce the strength of the culvert. The critical strength of reinforced concrete culvert pipe where the reinforcement does not exceed, say, 0.75 of 1 per cent., and is of medium steel, may be measured by the resisting moment calculated by the ordinary beam formula. This, of course, is with good concrete."

The British government has made some trials with gas engines on a gunboat, and, according to Lord Graham, the advantages are a reduced coal consumption by nearly 50 per cent., diminished space occupied, diminished weight, and marked saving in labor. Lord Graham reports that the further development of the gas-producer plant will give England the greatest labor economy it has ever had.

New Tools and Machine Shop Appliances

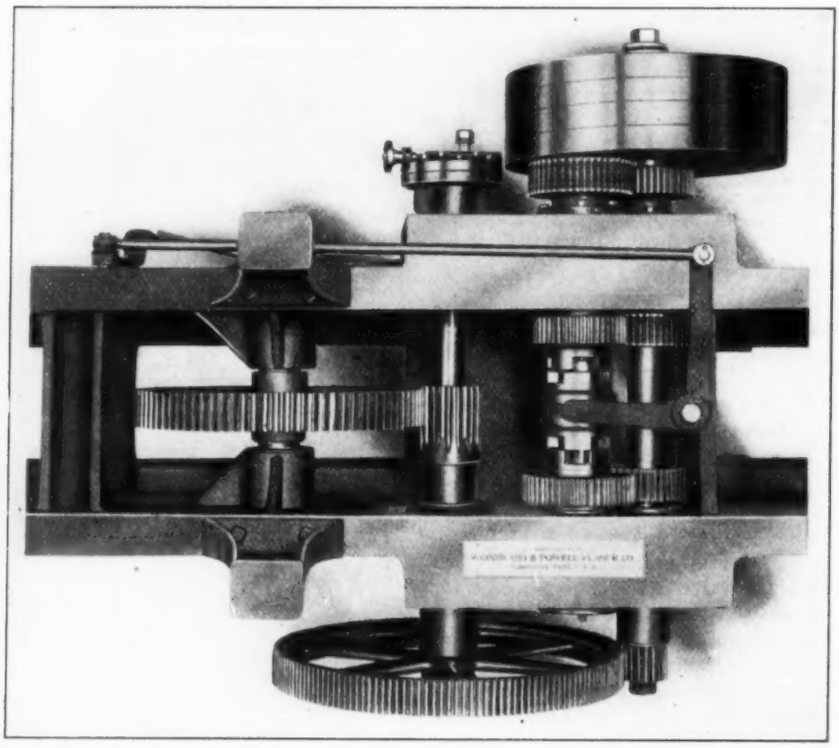
Showing New Ideas in Machine Shop Equipment That Make It Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

A Two-speed Planer with Powerful Drive

This is a device which gives two cutting speeds for table, and one constant return speed of the table. The lever on the front side of the bed operates the clutch which is mounted on the auxiliary shaft. The pulley which drives the table on the return is keyed fast to the main driving shaft; the pulley which drives the table for the cutting speed has a long hub on which the loose pulley revolves, and on the end of this hub is keyed a gear; this gear with pulley revolves loosely on the main driving shaft; this gear meshes into a rawhide gear which is keyed fast to the auxiliary shaft. The two clutch gears on the auxiliary shaft are loose, self-oiling, and are made of cast iron while the sliding clutch is keyed to this auxiliary shaft. These two gears mesh into rawhide gears which are keyed fast to the main driving shaft. The positive clutch and gears are of massive construction so that there is no danger of this clutch slipping out unless forced by the lever. In planing, the auxiliary shaft becomes the driver of the main shaft and being geared down, makes a powerful drive. On the return of the table, the main driving shaft on which the pulleys are mounted becomes the driver, with an ordinary variation of 1 to 1½.

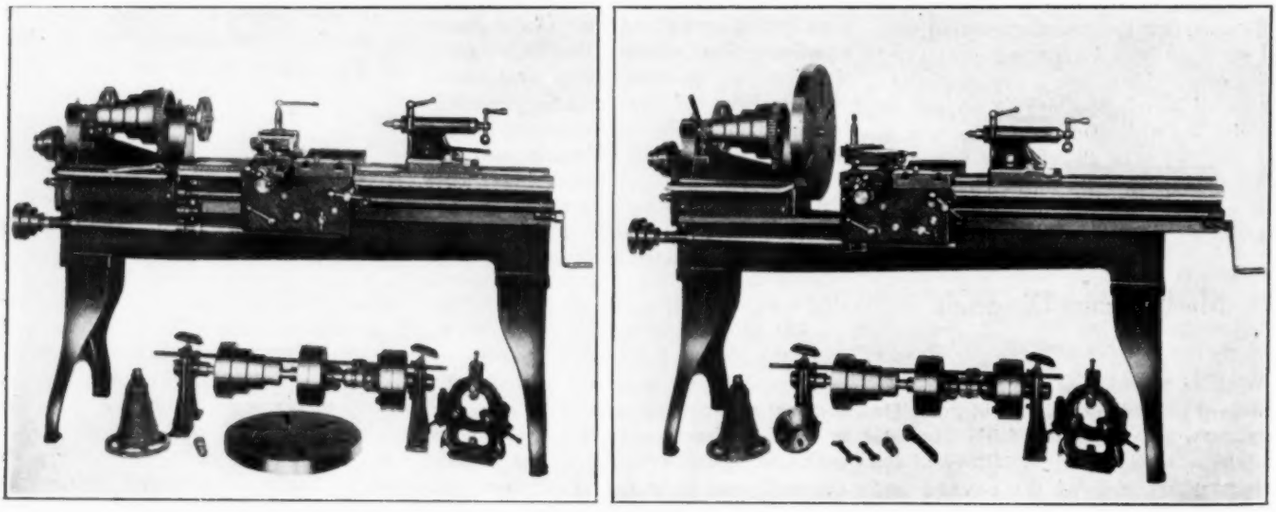
It is made by the Woodward & Powell Planer Company, Worcester, Mass.



THE UNDER SIDE OF THE TWO-SPEED PLANER

Extension Bed or Gap Lathe for Repair Work

This lathe has been designed to meet the needs of shops, such as automobile garages, that ordinarily need only a 12-inch lathe, but on occasions wish to swing a piece of work up to 22 inches. The upper bed is moved by a screw, operated by the crank at the end of bed. Power feed is transmitted by the short rod on the lower bed and then through three gears fastened to the left of the upper bed to the lead screw above. The lathe has sufficient power for the largest swing, has cross-feed to the carriage, takes 36 inches to 54 inches between cen-



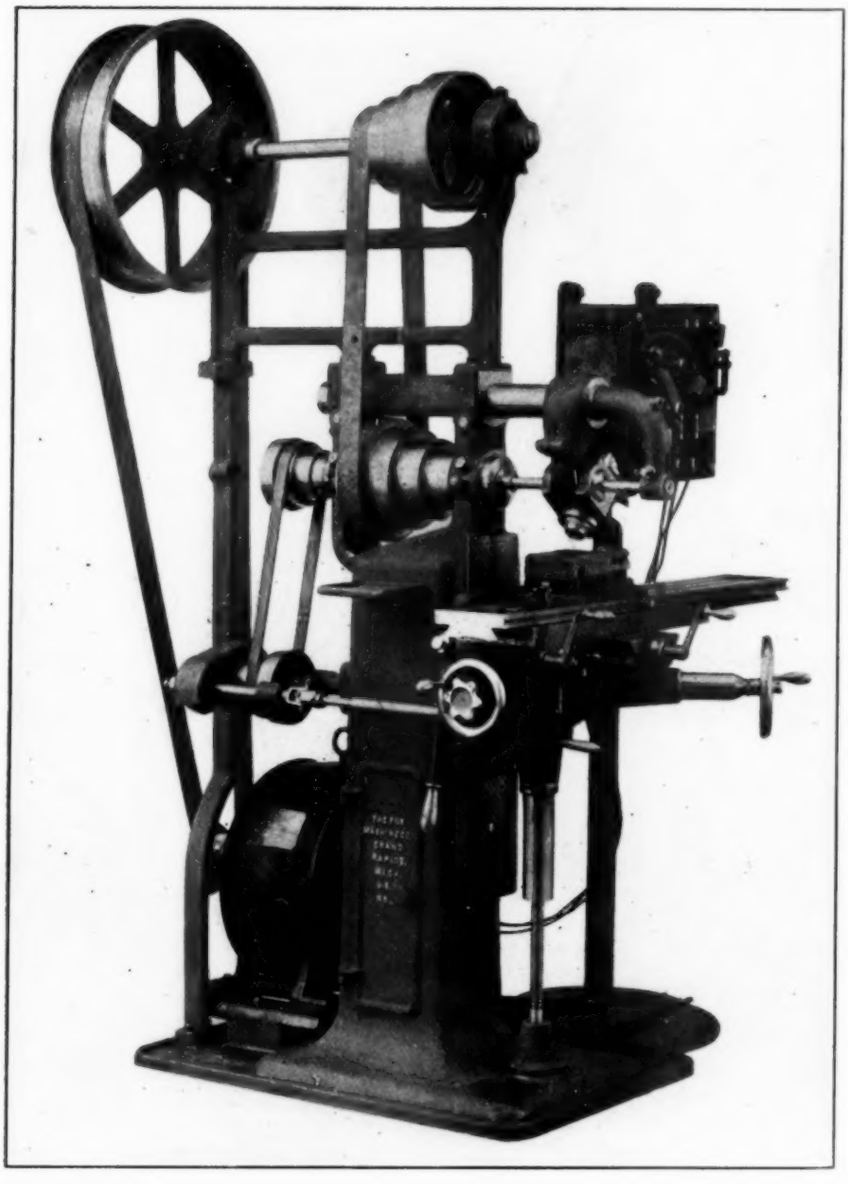
EXTENSION LATHE FOR GARAGE USE

ters, and with the gap gives an 18-inch opening. It is made by the Barnes Drill Company, Rockford, Ill.

A Variable-speed Motor-driven Milling Machine

The ilustration herewith shows a milling machine recently built for the Boston Navy Yard to conform with their specifications for motor drive. While this is a variable-speed motor, a constant speed can be used and still have eight speeds without back gears. The motor is hinged on the sub-base so as to act as a belt tightener, and is controlled by the treadle shown at the right of the machine itself. Placing the motor on the base adds to the stability of the whole machine. The controller is on a separate stand so as to allow it to be placed at any point which is convenient for the operator.

The feed of the table is somewhat out of the ordinary, combining rapid rack feed, a worm feed by hand, and also by power. This mechanism is contained in the casing under the end of the table. The handwheel at the end gives the slow worm hand feed, and when locked by the star wheel throws in the power feed from the universally jointed rod at the side. This rod drives a pinion located between two others, one driving a right- and the other a left-handed worm. Engaging either of these may be used to feed the table in either direction according to the position of the star wheel. For rapid feed the worms are dropped out of mesh with the gear which runs between the main worm and the rack and the table is then controlled direct by the handle in front or the lever behind the table.



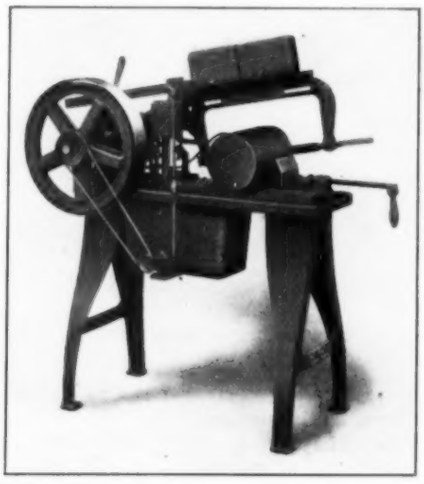
A MOTOR-DRIVEN MILLING MACHINE

The construction of the auxiliary angular milling spindle is a little out of the ordinary, and can be swung at any angle between the horizontal and vertical. This is a No. 3½ machine, and is made by the Fox Machine Company, Grand Rapids, Mich.

The Racine Power Hack Saw

This machine has a new automatic device for raising the blade on the return stroke.

This is made of steel and hardened,



POWER HACK SAW

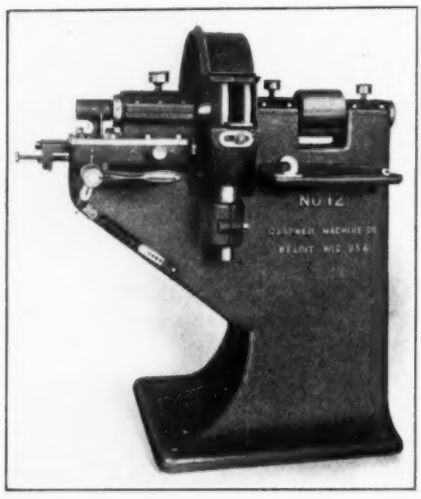
and consists of a ratchet bar and dog instead of a friction, making it positive. The machine is equipped with a rotary pump for circulating the cutting compound into a tank under the machine, being circulated over and over again.

In a machine having a positive lift on the return stroke, it is claimed to be almost impossible to break a blade by too much pressure on the blade. In severe tests as much as 80 pounds have been applied on a saw blade 14 inches long, 1 inch wide, by 1/32 inch thick, without injury to the blade. In such a test a 6-inch round steel bar has been cut off in 32 minutes.

The use of a cutting compound on a machine of this type is not unusual, but it allows the speed to be materially increased. This machine has a draw cut instead of a push, so that the blade is always pulled at full tension with no tendency to buckle. All bearings are extra large, the main shaft bearing being 6¾ inches long; the saw guide is cast in one piece, being in the form of a 1x2¼-inch I-beam, giving ample wearing surface. The saw frame is also in one casting, having provisions for taking up wear, with a special device for holding blade from 10 to 14 inches square with the chuck. This is built by the Racine Gas Engine Company, Racine Junction, Wisconsin.

Double Disk Grinder With Only One Pulley

This machine is designed for the rapid finishing of small pieces having parallel faces to be finished, such as bolt heads,



NEW DOUBLE DISK GRINDER

square or hexagon nuts, wrenches, thrust collars, die blanks, etc.

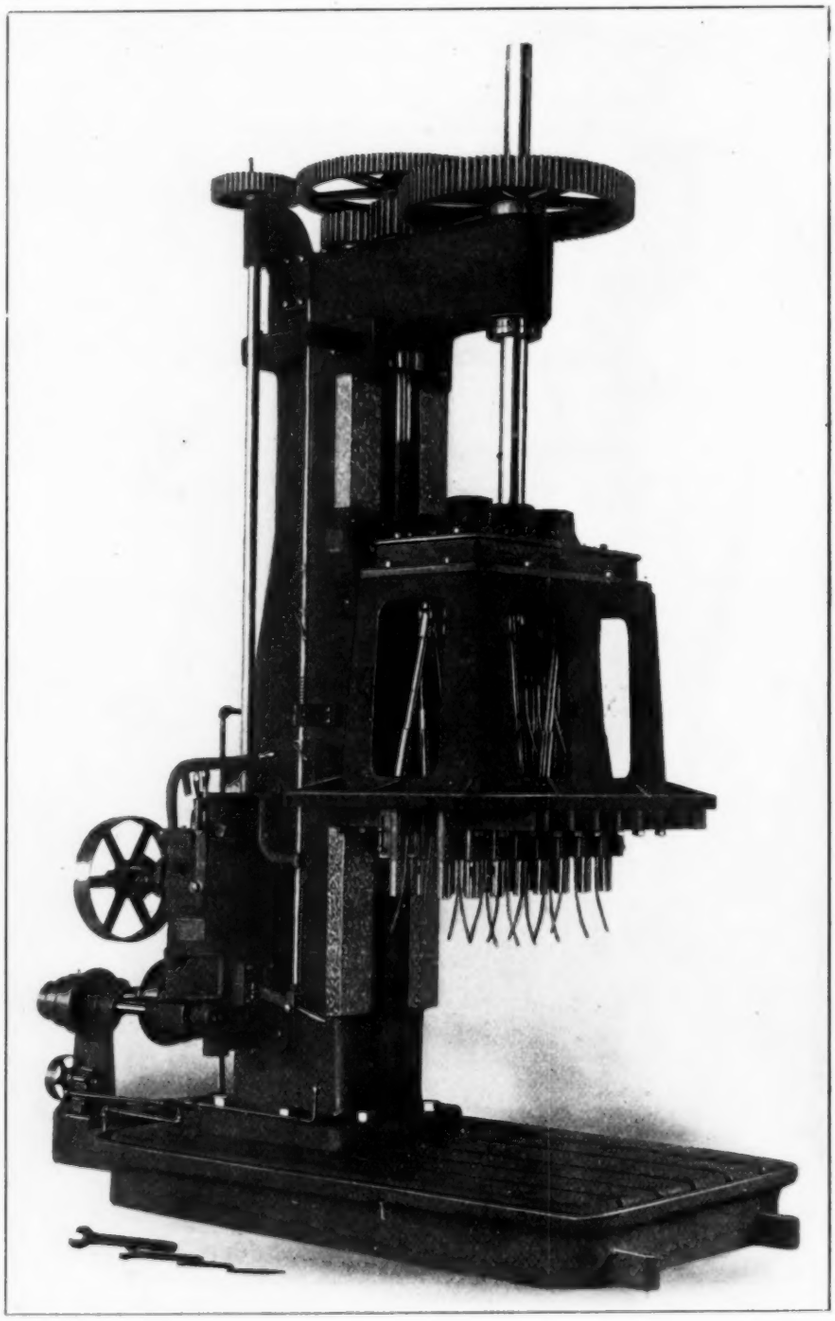
The chief feature of this machine is its one-belt drive, the left-hand disk wheel being mounted on a hollow spindle supported in the sliding head. A driving shaft coupled to the spindle carrying the right-hand disk wheel and driving pulley, drives the hollow spindle carrying the left-hand disk wheel. The drive-shaft is splined to engage a key fastened in the hollow spindle, and is provided with dust-proof collars to exclude dust from the hollow spindle. To remove the disk wheels from the machine it is only necessary to uncouple the driving shaft of the left-hand head, from the main spindle of the machine. The end of the drive shaft is made with a left-hand thread and taper seat, and the main spindle of the machine is bored and threaded to suit. The sliding head may be removed and special work table or fixtures used in connection with single wheel.

The sliding head is operated by means of a hand-lever which is directly connected to a pinion operating in a rack fastened to the under side of sliding head. The sliding head is equipped with micrometer stop-screws and back stop. This back stop is very useful in double-disk grinding—especially where thin work, from ⅛ down to 1/32 inch in thickness, is being ground. With it the backward travel of the sliding head is confined to the least possible amount required, to place the piece to be ground between the wheels, and thus removes the liability of the work being caught between the wheels and the work rest. The maximum distance between wheels is 4¼ inches, which in a great majority of cases is ample and may be increased to suit special cases. Disk wheels either 15 or 18 inches diameter may be used. This is being made by the Gardner Machine Company, Beloit, Wis.

Large Vertical and Horizontal Multiple Drills

These machines were designed and built especially for drilling the new structural steel shapes, called "Bethlehem sections," manufactured by the Bethlehem Steel Company, under the Grey process at its new Sancon plant. These shapes consist of new sizes of I-beams and also H-columns which are to be used in structural work in place of the built-up columns now in use. The equipment for this one plant consists of eight double-head horizontal and four single-head vertical machines, arranged in a line, with every other machine on a sliding base, to accommodate the drilling of various lengths, as may be required.

The double-head horizontal machines are made in two sizes—one carrying 12x48-inch heads, that is, the adjustable drill spindles cover any layout within a rectangle of these limits. These heads are equipped with 18 drill spindles each. The other size carries heads 12x24 inches, with 10 spindles to each head. Both heads on



LARGE MULTIPLE-SPINDLE DRILL

the horizontal machine may be operated independently or together at the will of the operator. The single-head vertical machines are also built in two sizes—one carrying 16 drill spindles on a working rectangle of 12x36 inches and the other carrying 10 drill spindles on a working rectangle of 12x24 inches.

All spindles have No. 3 Morse taper and are designed for drilling 1-inch holes in soft steel, at a speed of 55 feet per minute on the periphery of the drill, with range of feed up to 0.01 of an inch per revolution of the spindle. Each head is equipped with an oil pump, pan, reservoir and connections to each spindle, to allow of oiling each drill independently; also with a two-speed quick return of the drills.

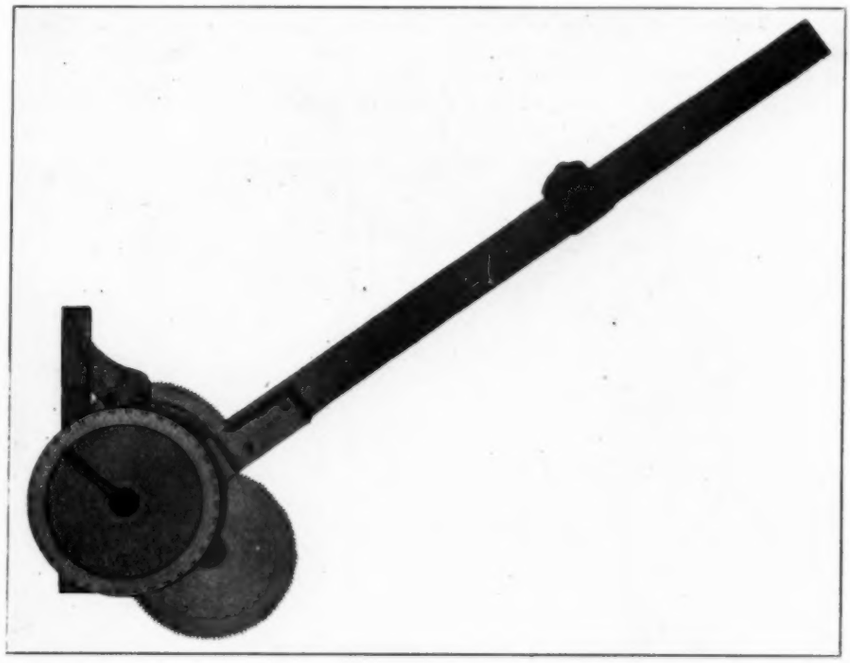
The double-head horizontal machines are for drilling flanges and the vertical are for drilling the web. This allows the necessary drilling with the minimum handling of the work. In the case of the double-head horizontal machines, each head sustains the drilling pressure of its opposite. In both styles of machine, each head is independently driven by a variable-speed motor, and in case of the movable machines, an extra motor is required for that purpose. The 18-spindle heads are driven by 25-horse-power motors, the 16-spindle heads by 20-horse-power motors, and the 10-spindle heads by 15-horse-power motors.

The vertical machines weigh about 11,000 pounds and the double-head horizontals about 25,000 pounds, without motors. These machines were built by the Baush Machine Tool Company, Springfield, Massachusetts.

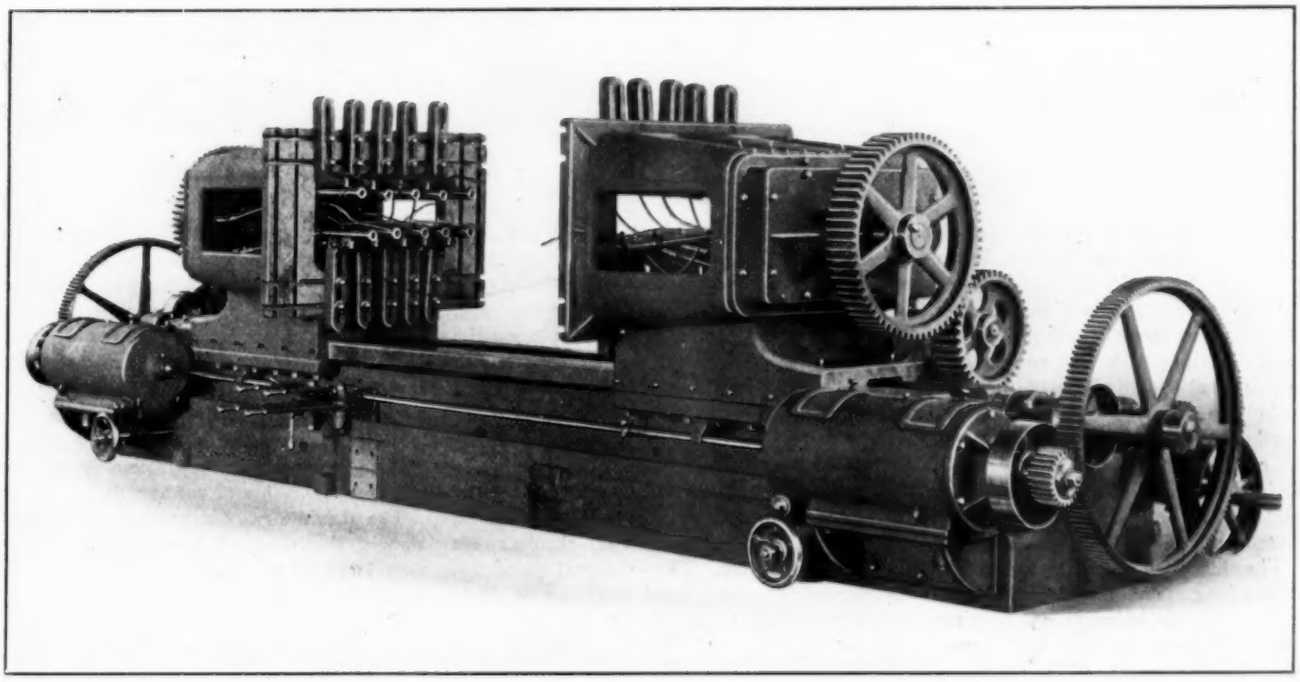
An Accurate Protractor or Anglemeter

This device is intended for laying out angles and dividing circles. It can be used on a drafting board as shown or attached to a metal plate, and its use is applicable to the tool room, drafting room and pattern shop. The center gear around which the arm swings has 144 teeth and can be placed in any desired position and is held stationary. The arm swings around this gear from its central stud, carries a pinion of 18 teeth attached to the end of spindle of large revolving gear of 135 teeth shown at the right, which meshes into the pinion of 18 teeth on the hand spindle. One revolution of the arm revolves the hand 60 times so that the dial, which is graduated in degrees, reads to minutes.

The illustration shows the device attached to the base piece and held on the edge of the drafting board as a bevel protractor. In this position the blade



AN ACCURATE ANGLEMETER OR PROTRACTOR



HORIZONTAL MULTIPLE-SPINDLE DRILL

will move through a half circle, or the base piece can be removed and the large gear held in the center of the board by thumb tacks passed through holes in the web of gear. In this position the blade is free to move through the full circle. One edge of the blade is radial with the center of stationary gear. A sliding block for scriber or pencil is attached to the blade, which can be moved along the blade and locked in any desired position. A strip of zinc divided into various numbers of divisions was sent us, which gives a very clear idea of the application and accuracy of the device.

The indicating hand can be set to any desired position in relation to the dial and clamped by means of nurled thumb screws shown. If a circle is to be divided into 144 spaces of 2½ degrees each, the radial face of the blade is set at the desired position, the hand moved to zero on the dial and clamped to spindle. The blade is then moved until the line on the hand coincides with 150′ on the dial, the line is marked and the blade next moved to indicate 300′, etc. For dividing uneven numbers as 47, a vernier hand reading to 5″ can be furnished. As 47 will not divide in even minutes the fractional parts of the minutes will have to be estimated on the dial.

The blade of the instrument is 12 inches long. The gears are made of german silver, the spindles and bearings are steel, hardened, ground and lapped and the complete weight is 20 ounces. It is made by the Schellenbach-Hunt Tool Company, Cincinnati, Ohio.

A Heavy Duty 20-inch Shaper

The main feature of this shaper is the bearings of the ram, as shown in Figs. 1 and 3. These bearings are flat underneath, but have angular sides and tops which fit into ways in the solid metal of the top of the column. This gives a large side bearing and a solid support against the lifting of the ram. The ratios of the bearing surfaces are so calculated that the ram will wear downward in its bearing, and the taper of the side bearings allows the wear to be automatically taken up. When the ram is in position in the column, and the wedge gibs are in place, the ram bearings are virtually surrounded on three sides by the solid metal of the column, making a very rigid construction.

The long slot in the rams, usually provided to accommodate the clamping stud, has been made unnecessary by placing the clamping device for binding the ram to the rocker-arm entirely within the shell of the ram. This allows the ram to be made of box form with an unbroken outer surface, and is cross-ribbed from side to side at short intervals its entire length. The binding device is operated from a wrench hold *C* projecting through the top of the ram. The construction of this clamping arrangement is shown at *D* in Figs. 3 and 4. As shown, the inner surface of the ram is provided with two projecting ribs *E*, which engage the positioning nut *F*. The lower rear end of this positioning nut is cut away to hold clamping plate *G* which binds on ribs *E* and the positioning screw *H* at the same time. The clamping is done by means of the eye-bolts 1 and the eccentric lever 2 operated by rack 3, which in turn is moved by pinion 4 on the internal end of *C*.

The tool head is of a familiar design, is graduated, and swivels through an arc of 90 degrees. It has an adjustable graduated collar reading to 0.001 of an inch on the down-feed screw. The tool-head slide has a graduated scale and pointer, to indicate at a glance the depth of cut, the pointer being adjustable so that it can be set to an even division of the scale. The clapper box is strengthened by a tie rib *J*, connecting both sides at the bottom, increasing the rigidity. The tool head is provided with power down feed, as shown at *K*, consisting of the rail 5, mounted on top of column, and the dog 6, adjustable along rail 5 and provided with a projecting pin 7, which engages with slotted lever 8. By this means a positive motion of lever is obtained in both directions, eliminating any spring arrangement to return the lever. Lever 8 is connected to the down-feed screw by suitable gearing, as shown, and the ratchet 9, which can be thrown in and out at will.

The driving gears are made unusually strong, the ratio of back-gearing being very large. The main drive consists of a four-step driving cone, which runs on the outside of a stem cast solid with column, a double sliding gear on the cone shaft, and back gears which connect with bull gear 13. On the other end of the bull-gear shaft is an elliptical gear 14, which

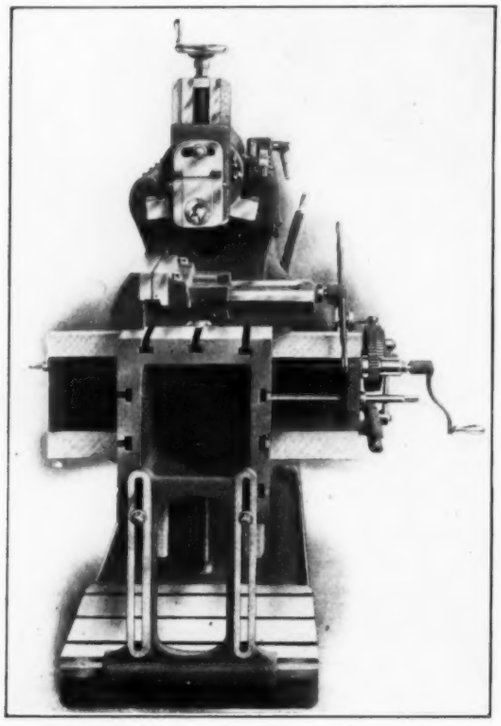


FIG. 1. FRONT VIEW SHOWING RAM

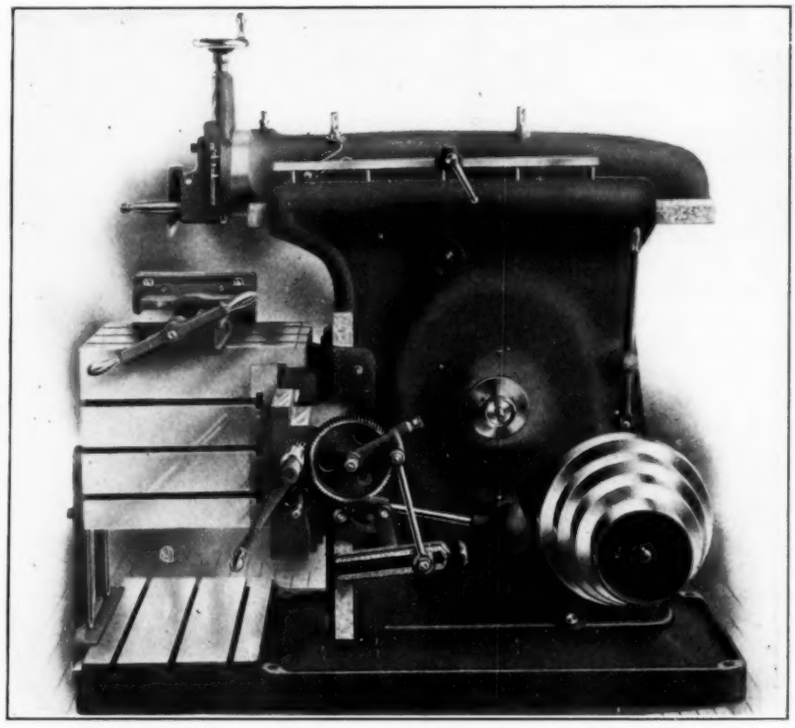


FIG. 2. SIDE OF SHAPER WITH FEED MECHANISM

runs with a second elliptical gear attached to the main driving crank 15. The use of elliptical gears gives a suitable return of ram and plenty of power during the cut, without necessitating excessive speed of any of the shafts and gears, and have been found preferable to the "Whitworth quick return." This drive gives eight cutting speeds for each length of stroke with a ratio of gearing with back gears of 32 to 1.

The length of stroke is adjusted by means of shaft 16 passing through the center of crank, and gears 17, which turn screw 18, and adjust nut and crank pin 19 so as to produce the desired length of stroke. The nut 19 slides upon suitable ways on the face of crank 15, and is provided with a long bearing, and a taper gib to take up wear.

The rocker arm is of unusual length so that when the ram is at the extreme end of the stroke, the rocker arm is less than 15 degrees from perpendicular, which eliminates much of the friction and wear on the ram bearings due to excessive angle of the rocker arm. The recess for the crank block is of box form as shown in Fig. 3, and is provided with a taper gib to take up the wear. The fork in the top of the rocker arm allows shafting to be passed through under the ram for cutting keyways. The pivot pin at the top of the rocker arm, connecting it to the positioning nut, has a very large bearing, is tapered to provide take-up for wear, and has a bronze bushing.

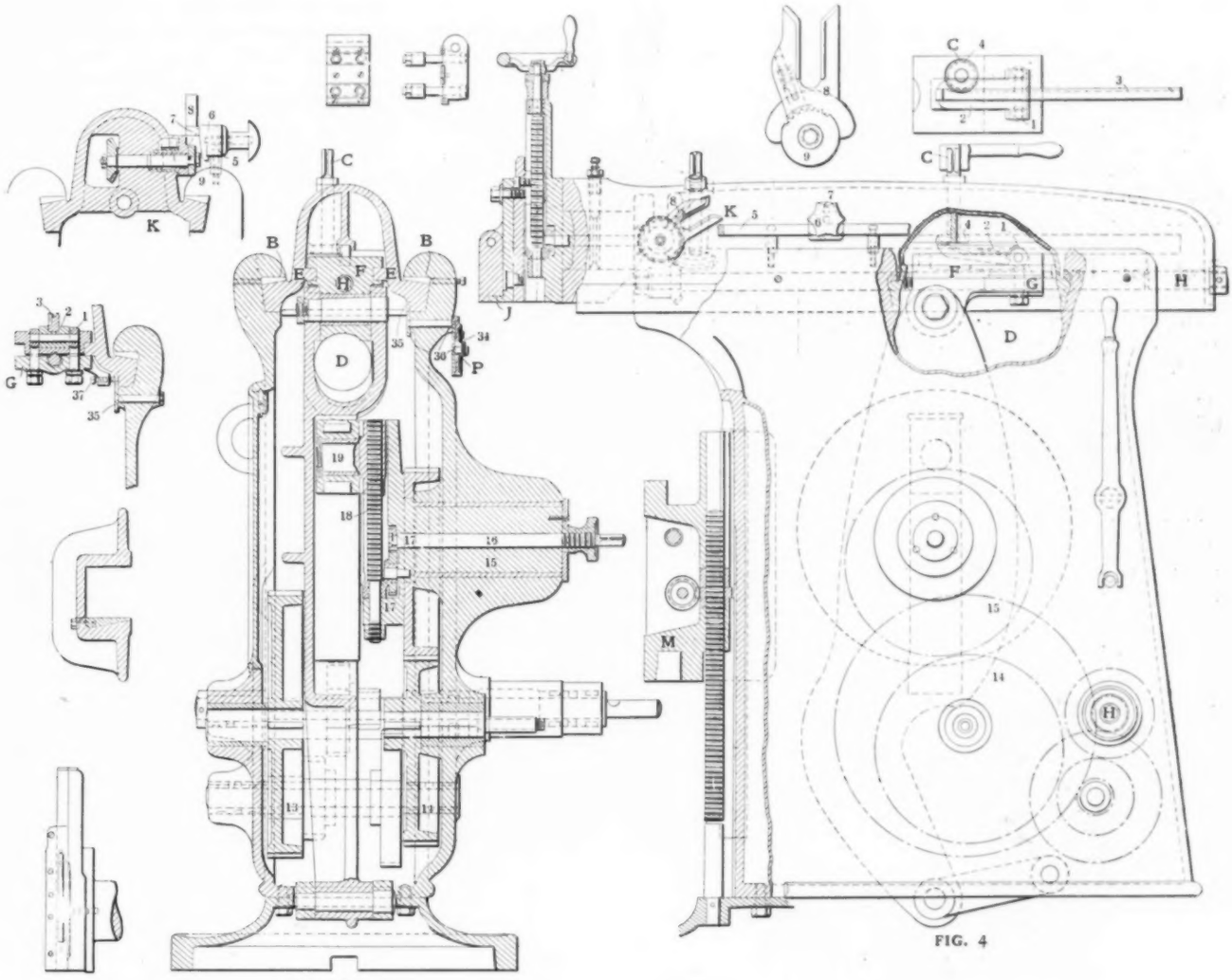


FIG. 3

FIG. 4

DETAILS OF CONSTRUCTION

The cross-rail is of box form, and is designed for allowing heavy cuts. The cross-rail bearings on the front of the column are made with the outside bearing at a slight angle to provide means to take up wear without having to rely upon the pressure of gib screws to maintain the alinement. The cross-rail is long and deep and provided with ample bearing surfaces for the apron. The apron is provided with a taper gib to take up for wear. The table is of box form, and can be readily detached to provide for clamping work to the face of the apron. The table is locked to the apron, and is a simple and effective way as shown in Fig. 2.

The cross-feed is obtained without the necessity for adjusting feed to correspond with hight of cross-rail. The cross-feed mechanism consists of miter gears, a splined shaft communicating motion from the bull-gear shaft to a small crank, which, through a connecting-rod, actuates the rocker. This rocker is provided with adjusting screw and trunnion nut, which connects it to the ratchet lever and to cross-rail screw through a spring clutch which provides a safety device so that if the table accidentally runs over to the extreme end of its travel, the pressure on the clutch teeth forces the clutch out of mesh, and prevents damage.

An index *P* is provided which shows the length of stroke, which is in the form of a dial on the side of the machine just above the stroke-adjusting shaft and is provided with a pointer that oscillates

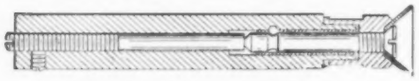
over the face of the dial. This pointer 34 is driven by gears 36 which are driven by rack 35, rack 35 being actuated by screw 37, which passes through a lug in the ram-positioning nut.

All bearings have bronze bushings, and all rapid-running bearings are provided with ring oilers. The driving cone is provided with two half bushings with oil chambers provided in the middle between these bushings. A splasher attached to the pulley throws the oil up and keeps the bearings thoroughly lubricated.

The vise rests flat upon the top of the table, thus forming the most rigid possible construction. It is provided with a graduated swivel base. The maximum stroke of the machine is 20 inches; the horizontal travel, 27 inches; length of ram bearing in the column, 36 inches; key-seating capacity 3½ inches; feed to head, 7 inches; width of machine belt, 3 inches. This is built by the Walcott & Wood Machine Tool Company, Jackson, Mich.

Tool for Truing Emery Wheels

The construction of this tool is easily seen, the cone-shaped end being fastened to the supporting cup and revolving

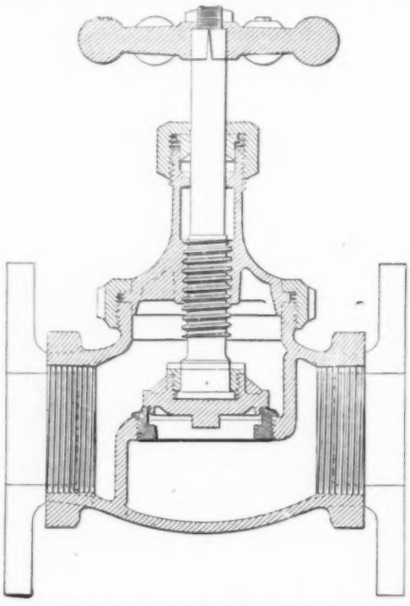


TOOL FOR TRUING EMERY WHEELS

with it, a felt or leather washer keeping the dust out of the bearing. The thrust is taken by the step bearing, a pin in the groove keeping it from falling out of the holder. This is designed to be held in a slide rest and moved across the face of the wheel. It is made by the Bay State Stamping Company, Worcester, Mass.

Globe Valve with Renewable Seat

The main feature in the globe valve shown herewith is the renewable seat which can be easily and quickly changed



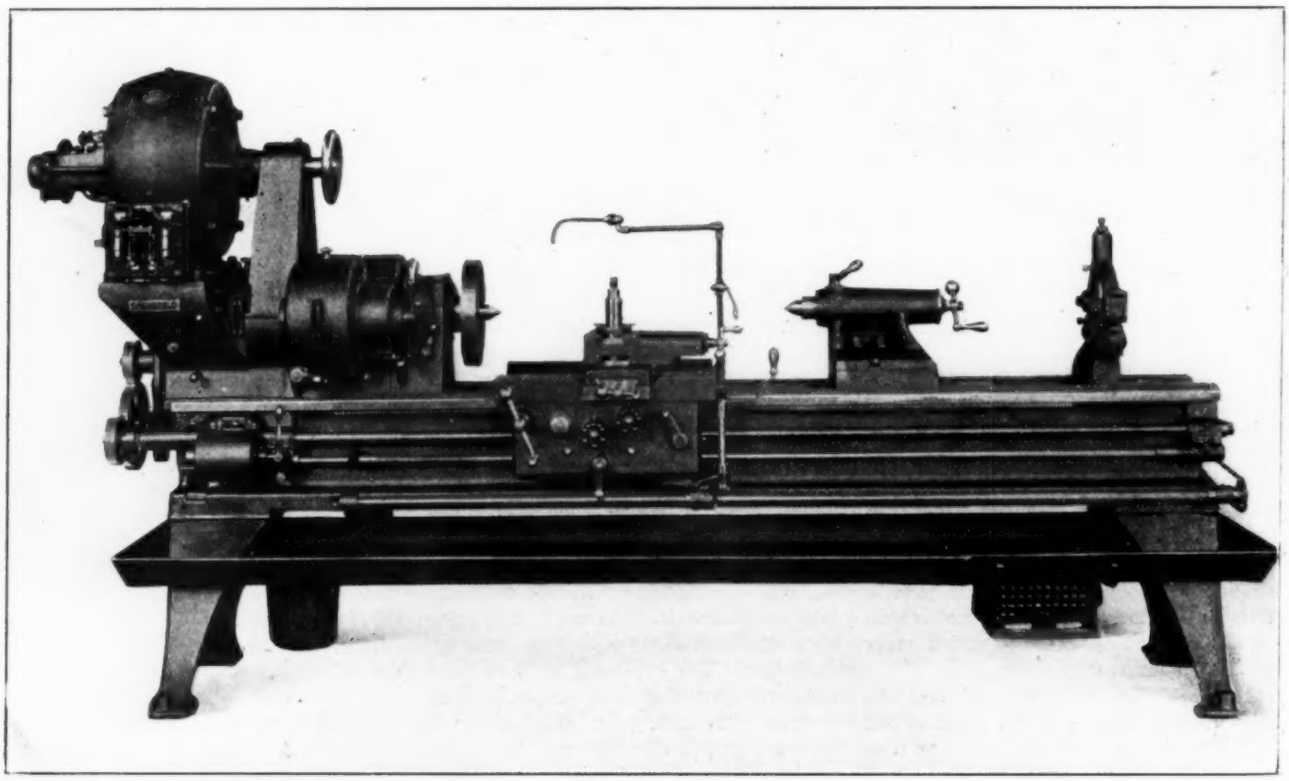
GLOBE VALVE WITH RENEWABLE SEAT

when worn or taken out for repairs. Another detail of construction which is a little out of the ordinary is the method of fastening the bonnet to the body by the coupling nut instead of screwing it in direct. This valve, called the "Renewo," is made by the Lunkenheimer Company, Cincinnati, Ohio.

Rapid Reduction Lathe

When this lathe is motor driven, the power is transmitted to the head by a silent chain drive, which is entirely inclosed, as is all the other gearing, insuring safety to the operator and preventing the throwing of oil. The head is heavily ribbed and tied together at various points. The spindle is heavy and runs in journals of lumen metal. Both the spindle and back shaft are oiled by means of triangular-shaped babbitt oil rings. All gears are of steel, and in cases where gears run directly on the spindle they are bronze bushed.

There are 10 changes of speed in the head, regardless of the motor, and with the 7½-horse-power variable-speed motor shown, which has a range of from 500 to 1000 revolutions per minute, practically any desired speed can be obtained. On the fast speed there is a direct drive from the motor to the spindle, while the next change is obtained through only one train of gears, consisting of one set of spur and one set of spiral gears, so as to secure a smooth, even cut. All clutches are of steel and positive, but so arranged that the machine need not come to a dead stop before changes can be made. When this lathe is arranged for a belt drive it is supplied with a two-speed counter-shaft,



NEW RAPID REDUCTION LATHE

giving 20 speeds in all, and is designed to give a constant cutting speed of 80 feet per minute for all diameters from 1½ to 18½ inches.

The whole machine is designed for very heavy work. The bed has one V and one flat way; the tailstock is exceptionally stiff; large lathe centers are used, having No. 5 Morse taper; there is a heavy carriage and compound rest with an apron of the double-wall type, and having extra-heavy gears. The rack pinion is made to be withdrawn when chasing threads.

This lathe is equipped with the new standard change gear, being a modification of the rapid-change gear system generally in use. In addition, however, the lathe is equipped with a rapid-speed changing box giving six feeds in a geometrical progression. It can also be equipped with the "Ideal" rapid-change gears manufactured by this company. It is built by the Springfield Machine Tool Company, Springfield, Ohio.

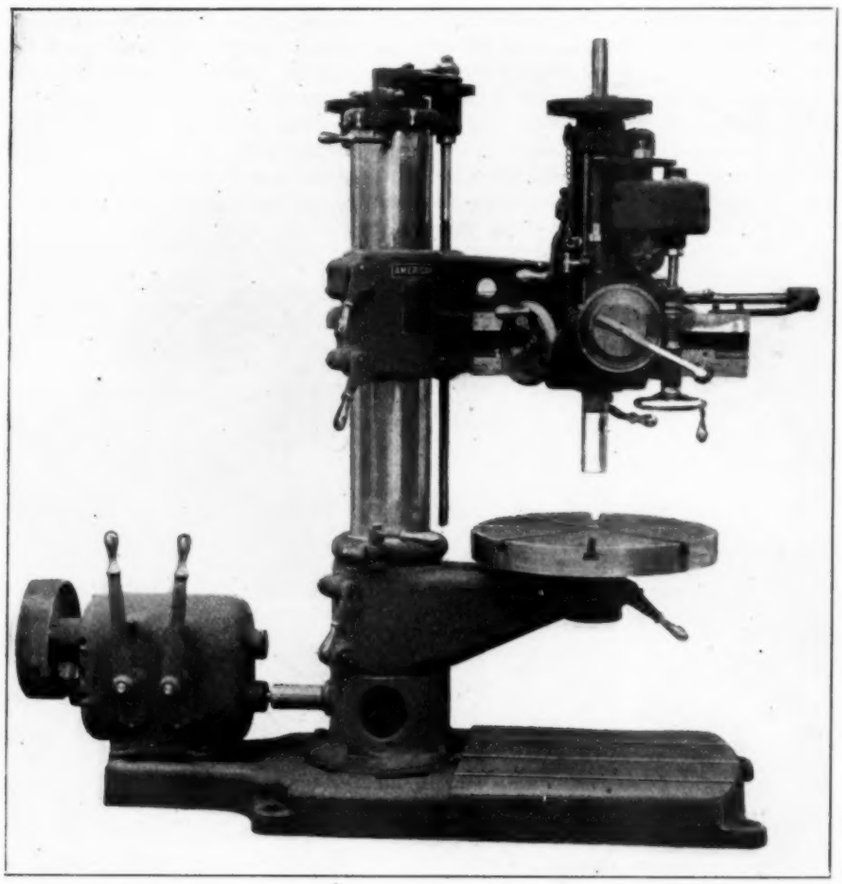
Small but Heavy Radial Drill

This machine has been designed to handle the heaviest work with high-speed drills, and though small in size, is heavy and rigid in every particular. To take care of the extra work imposed on it, special lubrication is provided for all bearings. The feed range covers from 0.007 to 0.02 inch per revolution of spindle with power changes in all, these being obtained by turning a knob in the feed box until desired feed comes opposite a fixed pointer requiring no reference to index plates or tables. There is a depth gage and an automatic trip, while a safety stop goes in automatically when the spindle gets to the end of its travel and prevents breakage.

A speed box is provided when wanted, giving four changes of speed by a powerful friction arrangement which obviates all shock in throwing in at any speed. The spindle has 16 speeds, ranging from 33 to 400 revolutions per minute in geometrical ratio, all of which are available without stopping the machine. A speed plate shows the proper speed for both carbon and high-speed drills.

The head carries the back gears and is moved by a special pinion in an angular rack. The tapping mechanism is also in the head, between the back gears and the speed box. Control of all motions of the spindle is by a lever on front of the head within easy reach of the operator. The column is double, the outer sleeve revolves on a conical roller bearing, and is clamped in any position by a V-ring, which can be moved around the column into any convenient position. This adds to the rigidity of the outer column by clamping it fast to the inner one. The arm is tubular in section and parabolic on the top; it is clamped by the two binder bolts shown.

An idea of the power of the machine can be had from several tests in drilling and tapping. In drilling tests more than 11 horse-power was consumed while the maximum depth drilled per minute was 5.8 inches in steel with a ¾-inch drill and 8.12 inches in cast iron with a 1 3/32-inch drill, both of high-speed steel. Taps were run in cast steel 1⅛ inches thick, at the rate of 4.8 inches per minute, with both 2½- and 3-inch pipe taps. In both cases over 9 horse-power was required. In tapping cast iron with 2-, 2½- and 3-inch pipe taps the rate was from 3.4 to 5 inches per minute, with from 4.24 to 5.75 horse-power. This drill is made by the American Tool Works Company, Cincinnati, Ohio.



HEAVY RADIAL DRILL OF SMALL CAPACITY

Stocking Cutter for Gear Teeth

The essential difference between the new stepped stocking cutter shown in the accompanying illustration, recently pat-

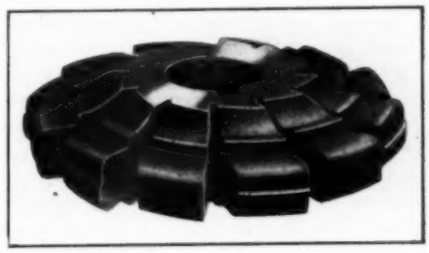


FIG. 1. STEPPED STOCKING CUTTER

ented by Gould & Eberhardt, Newark, N. J., and their former design is the relief-stepping of the tops of the teeth, so that each tooth practically takes out half as much as the usual stocking cutter. This new cutter also finishes the bottom of the tooth space, which relieves the finishing cutter of this amount of work

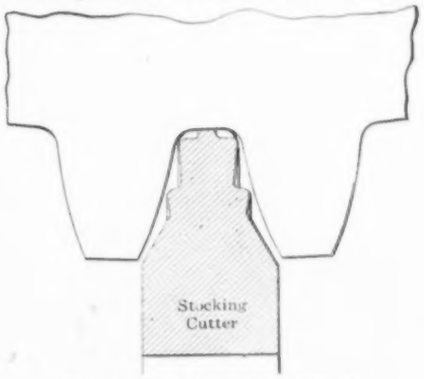


FIG. 2. THE STOCK IT REMOVES

and saves it at the point where it is very apt to wear out. They also make finishing cutters having these same features.

The cutting edges being staggered are more thoroughly lubricated while cutting, and in addition to finishing the bottom of the tooth, they cut out the stock near the point of the gear teeth, where the ordinary saw or stocking cutter leaves

large corners to be removed. They are also considerably wider through the hub than the usual cutter, which lessens the liability of keys being sheared off, and the combination of features permits faster feeds and speeds being used.

A Circular Milling Attachment

The accompanying illustrations show two applications of an improved circular milling attachment to the standard milling machine. Fig. 1 shows the attachment used in milling the faces of 12-inch pulleys, which by means of the power feed, is revolved against the inserted-tooth milling cutter screwed on the spindle. The table is adjusted slightly off-center longitudinally, resulting in a convex cut, and providing for the desired crown on the pulley face. It is not claimed that the milling machine in this job is the equal of a special or automatic machine designed for this purpose; the main advantage being that, in addition to the wide range of work possible on the standard miller, the use of this attachment accomplishes it satisfactorily and almost automatically. The extent of the cut and the consequent strain involved give an idea of the rigidity of the attachment.

Fig. 2 shows the attachment used in cutting a gear, 6 pitch, 18 inches diameter, which is far too large to swing in the dividing head. It is mounted horizontally on the attachment, and the power vertical feed on the miller is used in cutting the teeth. The worm-shaft of the attachment is arranged to readily receive the index-plate mechanism, as regularly furnished with dividing heads, and since the ratio of worm and worm-wheel is the same as on the dividing head, the full range of divisions is obtainable. The very large diameter of the worm-wheel insures accuracy. This makes the circular attachment in effect a dividing head, especially useful in cutting large diameter gears, which could not be handled easily in any other manner without the use of a special machine. Either of these jobs is such as might be encountered in any general repair or jobbing shop.

The attachment is built in two sizes, with 14- and 18-inch tables. The table has a solid bearing for almost its whole extent on the attachment base, and is clamped at any angle through 360 degrees through the same patent ring-clamping mechanism as is used on the universal millers. Table can be released from worm-wheel for rapid turning by hand. This is made by the Kempsmith Manufacturing Company, Milwaukee, Wis.

Machine Tools and Appliances Exhibited at the Master Mechanics' Convention

The importance of the railroad trade to builders of machine tools and shop appliances of all kinds must have impressed itself on every visitor to the exhibition of the Master Car Builders' and Master Mechanics' Association at Atlantic City, N. J., between June 17 and 24. Not only were the machine-tool builders more largely represented than ever before, but they were kept busy explaining the good points of their tools to railroad men from all over the country, and every exhibitor expressed entire satisfaction with the interest shown, and the results which they believed would follow. Among the exhibitors and their representatives were:

American Specialty Company, Harvey, Ill., "Use-em-up" drill sockets.

American Vanadium Company, Pittsburg, Penn., with samples of vanadium ore, oxides and alloys, together with samples of various applications of vanadium to springs, crankshafts, axles, lathe tools, rivet dies, ball races, etc.

The Armstrong Brothers Tool Company, of Chicago, Ill., displayed all of their well known tool holders, a new cutting-off tool and a drill-press vise.

Baker Brothers, Toledo, O., heavy drilling machine.

Bardons & Oliver, Cleveland, O., exhibited a 4x30-inch automatic turret lathe at work turning crank and wrist pins. They also had a No. 4 Universal brass-working turret lathe.

Beaudry & Company, Boston, Mass., a 150-pound Champion power hammer, and also had several small models to illustrate their working.

Charles H. Besly & Co., Chicago, Ill., had a No. 14 Besly spiral disk grinder in operation with geared lever feed to the table, in addition to their grinding disks or circles, babbitt metal, oil and taps.

Bethlehem Steel Company, South Bethlehem, Penn. While most of this exhibit was structural shapes, including their new sections, they had some very interesting turnings showing the possibilities of their tool steel.

Bickford Tool Company, Cincinnati, O. A 5-foot motor-driven full Universal radial drill was at work with various sized drills, some of which were fed through at the rate of 0.064 inch per revolution.

Hermann Boker & Co., New York, exhibited Novo and Intra steels, Novo drills and Novo patent sections of steel.

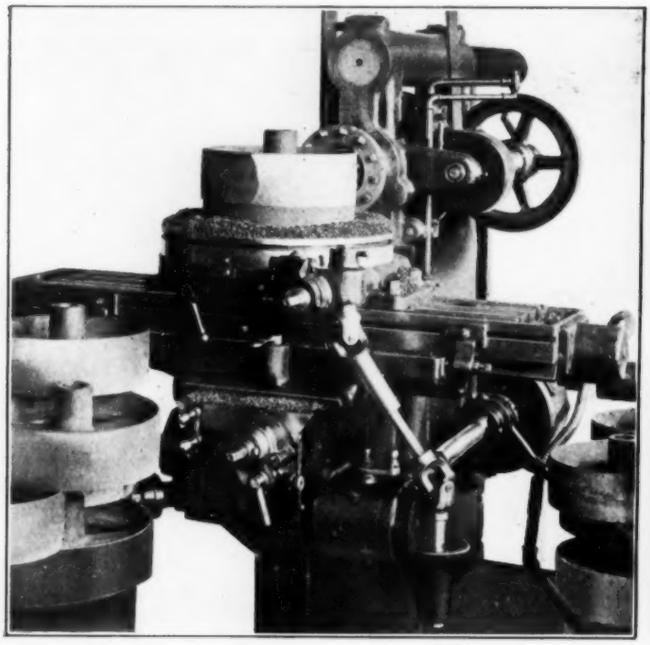


FIG. 1. MILLING CROWN PULLEYS

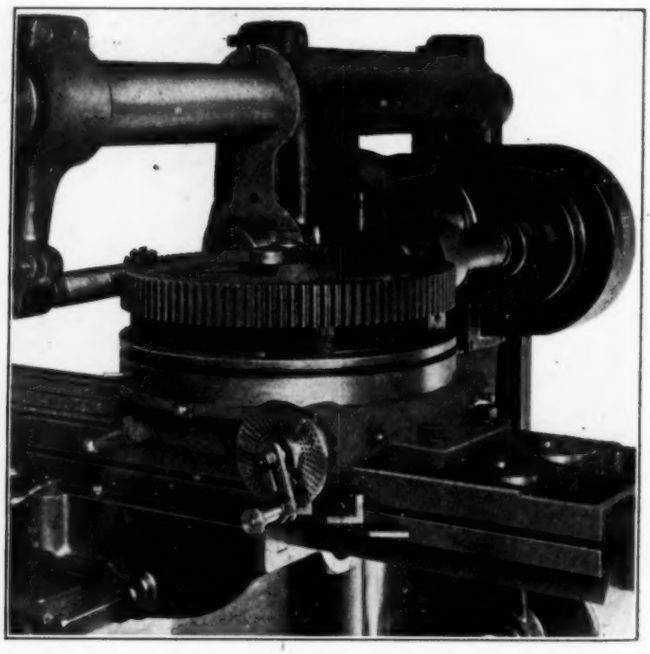


FIG. 2. CUTTING A LARGE GEAR

S. F. Bowser & Co., Fort Wayne, Ind., exhibited their system of oil storage and measuring outfits for tool rooms and similar places.

Brown & Sharpe Manufacturing Company, Providence, R. I. This exhibit consisted of a No. 3-A heavy Universal milling machine, a No. 5-B heavy plain milling machine, No. 3 vertical-spindle milling machine, together with the numerous attachments. These were in operation on various kinds of work. There was also a very interesting exhibit of cutters for milling machines.

Calculagraph Company, New York. Showing how these machines are used to record time of beginning and ending work, as well as elapsed time, so as to show the cost of various operations.

Carborundum Company, Niagara Falls, N. Y. Carborundum grinding wheels and sharpening stones, together with a large number of carborundum crystals, which are always attractive.

Celfor Tool Company, Chicago, Ill. Drilling test in which Celfor drills were used on a Baker Brothers heavy drill attracted wide-spread attention, as in one instance they forced a two-inch drill into cast iron at a speed of 350 revolutions per minute, at the rate of 26 inches per minute. The point of the drill was hot enough to set fire to wood, but was still ready for business.

Chicago Pneumatic Tool Company, Chicago, Ill., exhibited belt-driven air compressors, and a large variety of pneumatic tools for both wood and metal work.

Cincinnati Chuck Company, Cincinnati, O. A new four-jawed chuck having hardened-steel bearings for each end of the screws.

Cincinnati Machine Tool Company, Cincinnati, O. Two drill presses, one a high-speed 20-inch, and the other a very complete 24-inch sliding head, with back gear, positive-geared speed, quick return, and a geared tapping attachment which handled taps in a very interesting manner.

Cincinnati Milling Machine Company, Cincinnati, Ohio. Two of their new high-power milling machines, one horizontal and the other vertical. These are new types of machines which have just been completed and have many interesting and important features. They also exhibited a new form of milling cutter, which attracted much attention.

Cincinnati Planer Company, Cincinnati, Ohio. A forge planer 37x37 inches with an 8-foot table. This was motor driven through their feed box, and secures various speeds without the use of cone pulleys.

Detroit Hoist and Machine Company, Detroit, Mich. Exhibited geared pneumatic hoists from one- to ten-ton capacity.

Diamond Machine Company, Providence, R. I. A grinder for guide bars and similar work. Also a wet tool grinder.

Dixon Crucible Company, Jersey City, N. J. A line of crucibles, lubricating and other graphite preparations and specialties.

Dill Machine Company, Philadelphia, Penn. A slotting machine at work, and also three sizes of the new Dill drive for machine tools and other purposes.

W. H. Foster Company, New York. The Lassiter staybolt machine, bolt-tapering machine, staybolt drilling machine, and an automatic nut tapper.

General Electric Company, Schenectady, N. Y. Motor drives for wood- and metal-working tools.

Gisholt Machine Company, Madison, Wis. A 52-inch motor-driven vertical boring and turning mill, which was equipped with two swivel heads, and also a 24-inch Gisholt lathe, which turned out a large number of 6-inch crank-pins for locomotives. There were also a Gisholt Universal tool grinder and samples of tools.

Greene, Tweed & Co., New York. Favorite reversing ratchet wrench and specialties.

Goldschmidt Thermit Company, New York. Showed how welds could be made on driving-wheel spokes by the use of thermit, and gave exhibitions showing exactly how this was accomplished.

Harrington, Son & Co., Inc., Philadelphia, Penn. Exhibited a number of hoists for various purposes, including a four-wheel traveler to run on the lower flange of an I-beam, their "Peerless" and differential hoist, etc.

Independent Pneumatic Tool Company, Chicago, Ill. Piston air drills, air hammers, and air motors generally for application to small machine tools.

Philip S. Justice & Co., Philadelphia, Penn. Exhibited a 40-ton Reliance hydraulic jack and other jacks of 30 and 25 tons capacity.

Keystone Drop Forge Works, Chester, Penn. Keystone connecting links and safety shackle hooks, together with special forgings of various kinds.

Lancaster Machine and Knife Works, Lancaster, N. Y. Had a lathe equipped with their special turning attachment and examples of the various shapes that could be turned, ranging from the oval for driving twist drills and other revolving tools to making round-cornered square holes for use in automobile transmission gears.

Landis Machine Company, Waynesboro, Penn. Exhibited a motor-driven single-head bolt cutter.

Landis Tool Company, Waynesboro, Penn. A new Universal tool grinder motor-driven, a No. 3 Universal grinder, and a number of samples of the work done.

Lodge & Shipley Machine Tool Company, Cincinnati, Ohio. Exhibited one of their new 24-inch swing, geared-head engine lathes, equipped with a 10-horse-power Triumph variable-speed motor. The lathe was equipped with a new dog and also the Derrer attachment for turning odd shapes.

Lucas Machine Tool Company, Cleveland, Ohio. A No. 3 precision horizontal boring, drilling and milling machine, and a heavy railroad pattern power-forcing press.

Marshall & Huschart Machinery Company, Chicago, Ill. Various kinds of railroad machinery.

Mummert, Wolf & Dixon Company, Hanover, Penn. Plurality die and bolt cutter, revolving oil stone, Universal grinder and oil-stone scraper sharpener.

National-Acme Manufacturing Company, Cleveland, Ohio. A motor-driven Acme automatic multiple-spindle screw machine, which was at work on pins for locomotive valve motion.

Norton Company and Norton Grinding Company, Worcester, Mass. A pair of mounted car wheels, one wheel having flat spots, the other having been ground on a Norton car-wheel grinder; steel piston-rods, and other examples of grinding. A line of Norton grinding wheels of alundum and India oil stones.

A. O. Norton, Inc., Boston, Mass. Norton ball-bearing jacks of various kinds and sizes.

Pittsburg Automatic Vise and Tool Company, Pittsburg, Penn. Two-way high-speed vise, single-swiveled vise and pipe vise. One vise weighed 695 pounds and is said to be the largest ever made.

Joseph T. Ryerson & Sons, Chicago, Ill. Exhibited Lenox rotary-beveled shear, Ryerson high-speed friction saw, flue-welding machine, crank-pin truing machine, automatic keyseating machine, valve-seat facing machine, boring bar, punch and shear.

Scully Iron and Steel Company, Chicago, Ill. Flue-hole cutters, pneumatic tube expanders, staybolt taps, screw jacks, bevel shears, rotary shears.

Wm. Sellers & Co., Inc., Philadelphia, Penn. Two sizes of their tool-grinding and drill-grinding machines, in addition to their injectors and steam specialties.

Wm. J. Smith Company, New Haven, Conn. One-lock and micrometer adjustable reamers.

Springfield Machine Tool Company, Springfield, O. A high-power rapid-reduction lathe of 19-inch swing, fitted with an oil pan and pump, and driven by 7½-horse-power motor attached to the lathe.

Stoever Foundry and Manufacturing Company, Lebanon, Penn. A 3-inch motor-driven pipe-threading machine with new type of chuck for nipples.

Tindel-Morris Company, Eddystone, Penn. High-duty cold-sawing machine and inserted-tooth saw blades.

H. B. Underwood & Co., Philadelphia, Penn. A line of standard boring bars, locomotive valve-seat planers, portable pedestal planer, pipe-bending machines, etc.

Uwanta Wrench Company, Meadville, Penn. A line of monkey and combination wrenches.

Watson-Stillman Company, New York. Part of their line of hydraulic jacks, portable shaft straighteners, rail benders, etc.

Western Tool and Manufacturing Company, Springfield, O. Champion tool holders, expanding mandrels, portable benches and other of their specialties.

Wilmarth & Morman Company, Grand Rapids, Mich. Several new Yankee drill grinders, both belt and motor driven. Also wet and dry grinders, together with one of their combination cutter reamer and drill grinders. A new surface grinder and a loose pulley.

Wright Wrench Company, Philadelphia, Penn. A rapid-adjustment monkey wrench, clamped to a steel beam so that the handle was horizontal, and the handle loaded with about 800 pounds of pig lead.

Yale & Towne Manufacturing Co., New York. Electric "triplex" hoist, overhead trolleys, chain blocks, and a very interesting enlarged model showing the operation of a Yale lock.

Detroit Meeting of the Mechanical Engineers

A Digest of the Papers and Discussions Presented at the Spring Meeting of American Society of Mechanical Engineers, June 23 to 26, 1908

EDITORIAL CORRESPONDENCE

The spring meeting of the American Society of Mechanical Engineers was opened at the Hotel Cadillac, Detroit, Tuesday evening, June 23; the exercises of the first evening were limited to the conventional address of welcome by Mayor Thompson, of Detroit, and the reply by President Holman, of the society.

Wednesday Morning Session

The session of Wednesday morning was opened by a short business meeting in which were read the reports of the tellers of election and the announcement of the names of the members of the nominating committee. Under the subject of new business, ex-President Hutton referred to the great usefulness of the various reports of committees of the society on standard methods of conducting engineering tests of various kinds. Of these the report on testing internal combustion engines has proven extremely useful but it has now become more or less out of date and he moved that the council be instructed to request the gas power section to undertake the revision of the testing code. The resolution was passed.

Hoisting and Conveying Machinery

Following this came a symposium on hoisting and conveying machinery—five papers on various phases of this general subject being first read and then discussed together. Of these the first was by George E. Titcomb and covered the intermittent type of apparatus as illustrated by the ore-unloading machinery of the great lakes, the Dodge system of anthracite coal storage and machinery for unloading coal from vessels. The second paper was by Staunton B. Peck and was on the continuous type of machinery, including chain, spiral and belt conveyers—numerous illustrations of the various classes being included in the paper. The third paper was by C. K. Baldwin and related to the belt conveyer exclusively. It traced the growth of this type of apparatus and included numerous illustrations of the various modifications through which it has gone in the course of its evolution. The fourth paper was by C. J. Tomlinson and related especially to conveying machinery used in the portland cement industry and to the peculiar difficulties introduced in this application by reason of the extremely gritty nature of the material to be handled and the large amount of dust which accompanies its handling. The last paper was by E. J. Haddock, and consisted chiefly of an account of some experiments undertaken by the author to determine the effect due to variations in the diameter of the driving pulley, to variations of the arc of contact of the belt on the pulley, to variations of the initial tension of the belt, and to determine the value of rubber covered pulleys as compared with plain ones. The paper concludes with some general equations for practical application to belt conveyer problems.

The discussion of these papers was quite animated. Mr. Pattison criticized them as incomplete, saying that the type of ore-handling machinery most in use was passed over without mention, that undue prominence was given to machinery for handling anthracite coal and in general that much that should have been said was left unsaid. Mr. Wilcox discussed the handling of salt by belt conveyers, for which purpose this type of machine is suitable under some conditions, but not under others. He went into this subject quite extensively and described a special conveyer for this material. Mr. Pease discussed Mr. Baldwin's paper and sketched the history of the belt machine, paying special attention to the gradual reduction of the amount of troughing, and to the successive methods of constructing the idler carriers. He considered that the driving should always be done from the head end. He criticized some of the constructions shown as expedients rather than examples of correct practice. He did not regard the formulas given by Mr. Baldwin as reliable, and gave examples of cases in which they had led to very incorrect results. He also considered the rules for the diameters of the pulleys to be defective, and that the pulleys should be larger than these rules call for. Mr. Mesta did not agree with Mr. Pease regarding the diameter of the pulleys. Experience shows, he said, that the belts fail by surface and not by internal wear, this condition making it feasible to use smaller pulleys than those employed in power transmission. In conclusion he gave a formula for the power consumed which he regarded as substantially correct. Professor Carpenter discussed the paper by Mr. Tomlinson, saying that it gave an incorrect impression regarding the apparatus used in the cement industry—the screw conveyer being very largely used in that industry, although the contrary would be inferred from the paper. Professor Hibbard referred to the large field of usefulness for conveying machinery which is opening up in connection with locomotive coaling stations and defined some of the conditions which must be met, among which he placed absolute reliability as the first.

In the closure of the discussion by the various authors Mr. Peck criticized the statement that belt conveyers usually fail by surface wear, saying that this failure was often due to internal wear. Mr. Baldwin defended his formulas, saying that five years' experience with them had shown their reliability.

Wednesday Afternoon Session—Thermal Properties of Superheated Steam

This session was opened by a paper on "The Thermal Properties of Superheated Steam," by Professor Heck, in which he compared, discussed and combined the best available data from recorded experiments by Knoblauch, Jakob and Thomas.

After a critical study of these experiments he gives a table of the thermal properties of superheated steam, together with a three coördinate diagram of the probable true specific heat, and in conclusion expresses the opinion that "for all technical purposes the question of the

specific heat of superheated steam under constant pressure is about settled." In the absence of the author the paper was presented by Professor Breckenridge and he agreed with this conclusion of the author. In the discussion the same general opinion prevailed.

The next paper was on "A Rational Method of Checking Conical Pistons for Stress," by Professor Shepard, the nature of which is sufficiently indicated by the title. Supplementary to the mathematical deductions is a table of results obtained for the stress calculated by this method from drawings of the pistons used in the U. S. "Truxton."

The paper was discussed by Mr. Nizam who criticized the analysis as unsound.

Journal Friction Measuring Machine

The concluding paper of the session was on "A Journal Friction Measuring Machine," by Henry Hess. The machine which forms the subject of this paper has been designed by its author for determining the co-efficient of friction of ball bearings. It is capable of applying radial loads up to 15,000 and thrust loads up to 10,500 pounds under speeds ranging from 150 to 2500 revolutions per minute. The machine is noteworthy because of the fact that the friction to be measured is such a small factor of the applied load. After the description of the machine a few characteristic plotted curves are shown which are typical of the relation of load and friction in radial and thrust ball bearing, of the speed and load in collar thrust ball bearings and of the effect of ill treatment on the friction.

The discussion of the paper was highly complimentary, gratification being expressed at the appearance of an efficient machine for investigating ball bearings. It was pointed out that while a knowledge of this friction is of small importance from the general standpoint, it is nevertheless of the highest degree of importance in comparing bearings of different constructions, for which indeed it offers the most important of all tests.

In concluding the discussion Dr. Brashear asked for information regarding the beginnings of ball bearings, saying that, in dismantling a telescope made by the Gurleys in 1859, he had discovered such a being incorporated in its construction.

A Lecture and a Launching

During the evening of Wednesday the society listened to a lecture by Dr. John A. Brashear on "The Contributions of Photography to our Knowledge of Stellar Evolution." The attendance was large, and the audience was delighted with Doctor Brashear's enthusiastic words, while, to those who were not acquainted with the revelations of the photographic telescope, the lantern slides were wonderful.

Thursday morning the society was entertained by an excursion to the Great Lakes Engineering Works at Ecorse to witness the side launching of a 10,500-ton lake steamship. The trip was by water; the excursion boat was stationed for an excellent view of the launching, which was carried out without a hitch and promptly on time.

Thursday Afternoon Session—The Surge Tank in Water-power Plants

The professional sessions were resumed by the reading of a paper on "The Surge Tank in Water-power Plants," by R. D. Johnson. The paper describes a device intended to aid in the speed regulation and pressure relief of water powers with long pressure pipes and high velocities. The device is simple enough mechanically, but the determination of its proportions is a matter of some difficulty, and the paper is consequently quite mathematical, as was the discussion. Mr. Harzar had devoted a good deal of attention to the same subject, and developed a mathematical analysis of it which he submitted in writing and gave its outlines orally. He agreed with the author up to a certain point, but was then disposed to differ from him. Professor Church, on the other hand, objected to one of the first steps of the analysis, but the author contended that he had been misunderstood by Professor Church, and that his work was correct.

Pitot Tube Studies

The second paper was entitled, "Some Pitot Tube Studies," and was submitted by Profs. W. B. Gregory and E. W. Schoder. The paper describes some experiments undertaken to determine the effect of curves in pipes as regards the distortion of the distribution of velocities, together with the distribution of velocities in the curve. The paper contains both diagrams and tables, summarizing the results of the experiments. The discussion was somewhat extended, but brought out no point of special interest, except that Professor Eddy failed to see the usefulness of the down-stream tube which was included in the experiments.

Screw-thread Standards

The third paper was on "A Comparison of Screw-thread Standards," by Amasa Trowbridge. The paper gives curves comparing the Pratt & Whitney standard thread for machine screws, the United States standard bolt thread, the standard of the Association of Licensed Automobile Manufacturers, and the machine-screw standard of the society. The paper was read by Mr. Burlingame, who also discussed it. He stated that for many purposes the Brown & Sharpe Manufacturing Company had long used a finer thread than that of the United States standard, and he offered a formula of his own devising for a standard to meet conditions for which that standard is unduly coarse. This formula, while different from that on which the society's machine-screw standard is based, gives nevertheless the same results for all screws included within the range of that standard, while extended to larger sizes it is essentially Brown & Sharpe practice.

It was pointed out in the discussion that there is a real need and demand, for many purposes, for finer threads than those given by the United States standard, and that under these circumstances miscellaneous shop standards are springing up. It was urged that under these conditions the time is ripe for the society to provide a standard to prevent the further growth of this diversity, and a resolution was passed calling upon the council to appoint a committee for this purpose.

Identification of Piping by Colors

The concluding paper of the session was on "The Identification of Power-house Piping by Colors," by W. H. Bryan. The paper pointed out that the number, extent and variety of pipe lines in modern power plants has become so great as to result in confusion, uncertainty, delay and even accident—a condition which, in many plants, has led to the painting of different lines with distinctive colors.

The discussion was entirely favorable to the idea and it resulted in a resolution referring the matter to the council with power to appoint a committee to undertake the formulation of such a scheme.

The parallel session idea was adopted, the afternoon of Thursday being occupied with the session reported above, and also with a simultaneous session by the gas-power section of the society.

Friday Morning Session—Steam Engine Tests

The opening paper of the last session was on "Economy Tests of High-speed Engines," by F. W. Dean and A. C. Wood. Among the numerous steam-engine tests on record this is one of the first undertaken with a view to determine the economy of different types of engines after several years of use. The engines tested were of the single flat-valve, the four flat-valve and the piston-valve types. The authors close their paper with several conclusions of which perhaps the most important is that, the four-valve engines which were built to be more economical than single flat-valve engines, have utterly failed in their object. Another interesting conclusion is that no stationary high-speed engine is as economical as passenger locomotives in good order.

The discussion was quite animated. The more important points raised were that the cardinal principle of experimental work, that is, but one condition should be changed at a time, was ignored; in consequence some of the conclusions were uncertain. It was also pointed out that the loss of efficiency with wear was attributed entirely to valve leakage, the possibility of piston leakage was ignored. It has in fact been customary to assume pistons to be tight because condensation

makes leakage determinations almost impossible. Mr. Dawley had, however, made many experiments on the tightness of air-compressor pistons where these difficulties do not exist. He found leakages ranging between 5 and 15 per cent. R. H. Rice pointed out that the reduced effect of leakage undoubtedly explains in large degree the superior economy of the compound engine. Professor Goss contended that the loss of its economy by wear is not a reason for abandoning the four-valve engine, but for giving it better attention.

Air Leakage in Steam Condensers

The next paper was on air leakage in steam condensers, by T. C. McBride, who pointed out that while air leakage has a marked effect upon the capacity and efficiency of condensers no attempt has been made to determine the amount of air mixed with steam in ordinary practice, nor to define this amount in condenser contracts and guarantees. On the one hand, the greater part of the air coming to condensers is by reason of leakage; on the other, these leaks take place in those portions of the plant which the condenser maker does not supply, thus as the conditions stand the condenser maker in guaranteeing the performance of his apparatus is entirely at the mercy of others.

In the discussion some speakers considered the author's proposed method of relief from this condition through a specified amount of leakage to be entirely impracticable, while others endorsed his position.

Clutches

The concluding paper of the session was by Henry Souther on the subject of clutches, with special reference to automobile clutches. The paper illustrates the leading type of clutches now in use which are broadly divisible into the cone and multiple-disk types, to the former of which the author gives preference. In the discussion Mr. Mossberg contributed illustrations and descriptions of clutches used on power presses and C. W. Hunt contributed a valuable collection of data on the design and performance of clutches. Mr. Fay, president of the Society of Automobile Engineers, gave some striking examples of conflicting experience with automobile clutches and gave it as his opinion that either the cone or multiple-disk type is entirely satisfactory when suitably designed. This discussion concluded the formal program and, after the passage of suitable and richly deserved resolutions of thanks to the local committee, the meeting adjourned.

A Most Successful Meeting

During the afternoon and evening the members and guests were given a delightful sail down the Detroit river; supper was served at Bois Blanc island.

In point of the number in attendance the meeting was by far the most successful spring meeting in the history of the society. The registered attendance was over 700, whereas the high-water mark for previous spring meetings stands at 375.

Business Opportunities

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., July 13, 1908, for track scales, screw jacks, vises, repair parts for steam shovels and dredges, shafting, wire rope, condenser tubes, steel plates, bolts, rivets, iron-pipe fittings, track drills, drill chucks, grindstones, lubricating grease, etc., as per Circular No. 451

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids on the following dates: July 7, sprockets, pinions, wheels, steel, tools (schedule 42), fittings, water-gage glasses (schedule 34). July 14, motors (schedule 39), radial drill, engine lathe (schedule 40), automatic saw-sharpening machine, cold saw cutting-off machine (schedule 20), planer, circular rip saw (schedule 19). July 21, drills, hack-saw blades, sheaves, (schedule 16), seamless steel tubing, valves (schedule 17). July 28, rotary blower (schedule 37), electrical supplies, incandescent lamps (schedules 48 and 50).

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith Co., Columbia, Pa.

If you use small gears in large quantities, write Berry & Parker, Erie, Pa.

Steel case hardened; modern methods. Boston Gear Works, Norfolk Downs, Mass.

We buy or pay royalty for good patented machine or tool. Box 282, Amer. Mach.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Wanted—One old style No. 13 B. & S. milling machine. First-class condition not absolutely necessary. Box 234, American Machinist.

Wanted—Machinery or machine parts to build by contract. Ideas developed; drawings made. Address "A," care American Machinist.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Lathe and machine work of every description, patterns, gear cutting, screw machine work, iron, brass and aluminum castings. The Sipp Electric and Machine Co., Paterson, N. J.

Have you a March 7, 1907 issue American Machinist? We'll give you a month's subscription, or thirty cents, and a Steel supplement for it. American Machinist, 505 Pearl street, New York.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, American Machinist.

Machinists take notice. Purchase castings and blueprints of high-grade gasolene motor, of world-wide reputation and at a profitable business. Write today. F. P. Conrad, 242 Freeport St., Harrison Sq., Boston.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

Tools—Send your name and address on postal for our net priced catalog. Every machinist should have it. Montgomery & Co., 105 Fulton St., New York City.

Tomey's Scotch gauge glasses, made at Tay Glass Works, Perth, Scotland, are sold by Montgomery & Co., 105 Fulton St., New York City. Beware of imitations, and don't take the "just as good as —."

Wanted—A good working partner with small capital can secure interest in a well equipped machine plant, established over 20 years, located on line of P. R. R. and P. & R. railroads, between New York and Philadelphia. Write for particulars. "W.," American Machinist.

We have an attractive proposal for a shop suitably equipped to build machine tools weighing 1300 to 4000 pounds. An ideal line for a profitable, permanent addition. Little competition. Box 258, American Machinist.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CALIFORNIA

Foundry foreman, fifteen years' experience in big shops. Hustler, with understanding to bring best work out of employes. Wishes position again as foundry foreman in California. Box 263, American Machinist.

ILLINOIS

Up-to-date tool room foreman desires change; experienced on design and construction of sub-press dies, and tools for manufacturing adding machines, cash registers and small arms. Age 30. Married. References furnished. Box 241, American Machinist.

MASSACHUSETTS

Automatic machine designer, twelve years' experience. Box 260, American Machinist.

Expert grinder wishes position on fine tool work. Box 261, American Machinist.

Designer and engineer is open for position on manufacturing equipment, machine tools and special machinery. Thirty years old, twelve years' experience in shop and office; Eight years as chief. Box 264, Am. Mach.

NEW JERSEY

Mechanical draftsman, experienced on automobiles and automatic machinery. Any location. Box 266, American Machinist.

NEW YORK

Experienced tool and diemaker. First-class references. Box 223, American Machinist.

Position as superintendent by practical mechanic with experience in keeping costs where they belong. Box 200, American Machinist.

Draftsman, graduated mechanical engineer, three years' drafting experience, desires employment. Box 268, American Machinist.

Expert mechanic, constructor and designer for delicate electric and mechanical apparatus, executive ability, desires change. Box 254, American Machinist.

Mechanical draftsman, experienced on marine gasolene motor and jig design. Best references. Now employed. Will go anywhere. Box 256, American Machinist.

Position wanted as draftsman, or as designer and developer of automatic machines and electric appliances. Practical man, twelve years' experience, good reference. Box 259, Am. Mach.

Designer, twelve years' all round experience, automatic machinery, steam engines and turbines, presses, dies, etc., wants opening where originality and ingenuity will count. Box 265, care American Machinist.

WISCONSIN

Position as superintendent or works manager. Entire charge, a hustler with a record as an earning power, who has never failed to make good. A-1 references. Look me up. Address Box 269, American Machinist.

Help Wanted

Classification indicates present address of advertiser, nothing else.

ILLINOIS

Wanted—Metal core-box maker to machine core-boxes from solid casting or soft steel. This work is similar to die sinking. Application must state age, experience in detail, references and salary required. H. Mueller Mfg. Co., Decatur, Illinois.

INDIANA

Wanted—By an old and firmly established

manufacturing concern, a thoroughly qualified man to take entire responsibility of tool department employing 20 to 30 hands. There must be no question as to ability to produce all characters of our tools at costs in keeping with degree of refinement, which varies from the highest character of small interchangeable tools to tools for rough, coarse work. The position is permanent to the right man and larger possibilities are before him. State age, references and salary. Box 238, AMER. MACH

Wanted—Five (5) first-class toolmakers. Box 255, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—An assistant superintendent for a factory employing 300 men, manufacturing small tools; age 30 to 40 years. A good man with lots of ambition, even though he has not had experience as a superintendent, would be tried. Box 242, AMERICAN MACHINIST.

Production man for company manufacturing monkey wrenches and a line of special wrenches. Man preferred who has a successful record on this kind of work. Good opportunity for man who can produce results with piece work. Box 257, AMERICAN MACHINIST.

MICHIGAN

Sales manager wanted; competent to take charge of selling end of a young, growing marine engine and machine business, must invest from $3000 to $5000. Address Box 251, AM. MACH.

MISSOURI

Superintendent for our gas engine works, able to organize a perfect shop system; get work out economically and accurately. An ordinary shop foreman or theorist will not do. Salary, $1800 upwards; chance for something else. Witte Iron Works Co., Kansas City, Mo.

NEW JERSEY

Wanted—A machine-tool designer; one who can lead a small force of men. Must have had practical experience along a line of medium heavy work. Quick to comprehend and thoroughly familiar with detail work. Salary $30 per week. Permanent position. Box 237, AMERICAN MACHINIST.

NEW YORK

Wanted—Instrument makers, experienced in calibration of automobile speed indicators. Liberal wages to first-class men. Box 236, AMERICAN MACHINIST.

Wanted—As an assistant foreman, a first-class toolmaker who has had experience on building machinery and small tool work. Box 224, AMERICAN MACHINIST.

Bright, ambitious tool maker, 25 to 30 years of age, capable of economically producing dies and fixtures for small intricate interchangeable work. Must be strictly up-to-date and show a clean record. Box 267, AMERICAN MACHINIST.

Wanted—Draftsman, designer and practical machinist to design attaching fittings for automobile speed indicators. Good salary paid to right man. None other than experienced high-grade man need apply. State references and experience. Box 235, AMERICAN MACHINIST.

Wanted—General foreman for machine shop manufacturing special and automatic machinery, machine tools, etc. Must be thoroughly competent mechanic and experienced executive, with personality and push to produce results at minimum cost without friction. Exceptional opportunity for right man who can grow with progressive and rapidly developing business. Address, giving experience in full, also age, references, nationality and salary expected. Box 262, care AMERICAN MACHINIST.

OHIO

Wanted—Superintendent and designer of screw machines and turret machinery. Box 217, AMERICAN MACHINIST.

Wanted—Screw machine hands for Cleveland automatic, Potter & Johnston and Warner & Swasey hand screw machines. State experience, wages and when available. Address, The International Harvester Company, Akron, Ohio.

PENNSYLVANIA

Wanted—Salesmen (traveling or local) selling the machinery or supply trade or consumers. Challenge Machine Co., Inc., Philadelphia, Pa.

Wanted—Two men thoroughly experienced in the hobbing of pipe-threading dies, also familiar with the various complications of high cutting speeds. None but first-class men need apply. Highest wages paid. Box 216, AMERICAN MACH.

WISCONSIN

Wanted—A splendid opportunity for mechanical engineer with capital to invest in engineering school. Must be university graduate and have talent to teach mechanical engineering in all its branches. Address Box 252, AMER. MACH.

Help Wanted—Engineering school of highest standing offers excellent position to mechanical engineer as instructor in all branches of mechanical engineering and construction. Must have talent. State age, experience and salary expected. Box 253, AMERICAN MACHINIST.

For Sale

For Sale—One second-hand Uehling Steinbart & Company pneumatic pyrometer complete with recording gage. Box 140, AMERICAN MACHINIST.

Tool Holder Patent—Beats anything now on the market. Price reasonable. Address "Tool Holder," AMERICAN MACHINIST.

For Sale or Rent—Foundry, machine and wood working shop, also blacksmith shop, in fine village of 5000, with use of machinery. Fine opening for a good business. Box 227, Bergen, N. Y.

For Prompt Sale—An entirely new equipment of patent machine tools, used but little, some not at all. It's a rare chance. Particulars sent, or can be seen at our factory. Fine plant for sale. Stratton Engine Co., Fitchburg, Mass.

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Dickinson, Thos. L., New York.
Monarch Emery & Corundum Wheel Co., Camden, N. J.
Norton Co., Worcester, Mass.
Pittsburg Emery Wheel Co., Pittsburg, Pa.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.

Air Lifts

Ingersoll-Rand Co., New York.

Alundum

See Grinding Wheels.

Arbor Presses

Barnes Co., W. F. & John, Rockford, Ill.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arbors

Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Twist Drill Co., Athol, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arbors, Expanding

Cochrane-Bly Co., Rochester, N. Y.

Balancing Ways

Bowsher Co., N. P., South Bend, Ind.

Barrels, Steel

Lyon Metallic Mfg. Co., Aurora, Ill.

Barrels, Tumbling

Globe Machine & Stamping Co., Cleveland, O.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Krieger Tool & Mfg. Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Bearings, Ball and Roller

Boston Gear Works, Norfolk Downs, Mass.
Hess-Bright Mfg. Co., Philadelphia, Pa.
Hyatt Roller Bearing Co., Harrison, N. J.
Iroquois Mach. Co., Providence, R. I.

Belt Dressing

Cling-Surface Mfg. Co., Buffalo, N. Y.
Desmond-Stephan Mfg. Co., Urbana, Ohio.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Fasteners

Bristol Co., Waterbury, Conn.

Belt Filler

Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Lacing Machine

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belt Shifters

The L. & D. Co., Boston, Mass.

Belting, Leather

Chicago Raw Hide Mfg. Co., Chicago, Ill.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Benches, Work

Manufacturing Equipment & Engineering Co., Boston, Mass.

Bending Machinery, Hydraulic

Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Bending Machines, Plate

Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Toledo Machine & Tool Co., Toledo, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Bending Machines, Power

Bertsch & Co., Cambridge City, Ind.
Bethlehem Foundry & Machine Co., South Bethlehem, Pa.
Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Swaine Mfg. Co., Fred. J., St. Louis, Mo.

Bending Tools, Hand

Estep & Dolan, Sandwich, Ill.
Wallace Supply Co., Chicago, Ill.

Blanks, Nut and Screw

Electric Welding Products Co., Cleveland, Ohio.

Blocks, Chain

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Blocks, Die

Nicholson & Co., W. H., Wilkes-Barre, Pa.

Blowers

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Roth Brothers & Co., Chicago, Il

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Sturtevant Co., B. F., Hyde Park, Mass.

Blue Print Machines

Keuffel & Esser Co., Hoboken, N. J.

Blue Print Paper

Keuffel & Esser Co., Hoboken, N. J.

Bolt and Nut Machinery

Acme Mchry. Co., Cleveland, O.
Boynton & Plummer, Worcester, Mass.
Davis Machine Co., W. P., Rochester, N. Y.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
Manville Mach. Co., E. J., Waterbury, Conn.
McCabe, J. J., New York.
Milton Mfg. Co., Milton, Pa.
Mummert, Wolf & Dixon Co., Hanover, Pa.
National-Acme Mfg. Co., Cleveland, O.
National Machinery Co., Tiffin, O.
Newton Machine Tool Wks., Inc., Phila., Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolt Heads

Lang & Co., G. R., Meadville, Pa.

Bolts and Nuts

Electric Welding Products Co., Cleveland, Ohio.
Milton Mfg. Co., Milton, Pa.
National-Acme Mfg. Co., Cleveland, O.